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FOR SPACE SHUTTLE MISSION STS-32 (61-C)
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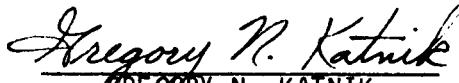
Ice/Frost/Debris Assessment For Space Shuttle Mission STS-32 (61-C)

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FOR
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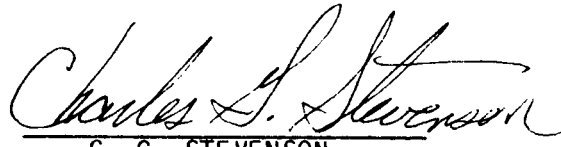

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FORWARD

The Debris Team is continuing its effort to develop and implement measures to control damage from debris in the Shuttle operational environment and to make the control measures a part of routine processing and operations.

STS-32 (61-C)
PRE-FLIGHT VEHICLE/PAD DEBRIS INSPECTION
FIRST SCRUB (SRB HPU)

A Pre-flight Vehicle and Pad Debris Inspection was conducted at Pad 39A on 18 December 1985 at 1200 hours and included the following mission elements:

- o OV-102 (7th flight)
- o ET-30 (LWT 23)
- o B1024
- o MLP-1

Both the vehicle and pad were inspected for potential sources of vehicle damaging debris. Photographs were taken of the inspected area.

Small amounts of debris similar to that found on previous pre-launch inspections was noted including the following items:

- Plastic shim material (3" x 12") in HDP #6 well area
- SRB aft skirt instafoam overspray splattered on HDP #6
- Wire cable (safety restraint) at sound suppression downpipe near HDP #6 well area.
- Bolt, rope and plastic materials under raised platform adjacent to and on the north side of the L02 TSM.
- Piece of rope from overpressure water troughs near HDP #4.
- Grouting at base of L02 TSM cracked with piece broken loose along north side of base.
- Piece of foam under raised deck east of RH SRB.
- Foam debris on raised deck area beneath ET/ORB L02 umbilical.
- Grit on east side of MLP raised deck.
- Plastic bags in RH SRB water troughs (2nd and 3rd from north end of SRB hole).
- Shim stock (1" x 3") in HDP #2 well area.
- Shim stock (1" x 1-1/2") under metal lip south west of HDP #2.
- Pieces of K5NA material in HDP #1 well area.
- Protective cover for SRB HDP bolt mount on MLP deck.

Although the cleanup was still in progress at the time of this inspection, the overall cleanliness of the pad was considered good. Continuing improvement in the amount of pad debris has been noted. No vehicle configuration anomalies were observed during this inspection. The attempted launch on 19 December 1985 was scrubbed because of a turbine overspeed in the RH SRB hydraulic power unit (HPU).

STS-32 61-C
T-3 HOURS/ICE/FROST INSPECTION
FIRST SCRUB (SRB HPU)

On Pad Inspection Time: 0145 - 0310/December 19, 1985

Cryos Loaded From: 0127 - 0900 EST

Temperatures: 65.7° - 55.2°, 59.0°F Average

Winds: 6 - 13 knots, 9.9 knots average
from the southwest

Relative Humidity: 60 - 83%, 73.8% average

Dew Point: 48.6 - 52.4°F, 50.5°F average

SOFI Temperature: 33.9 - 51.5°F, 42.7°F average

The TPS Ice/Frost and Debris Inspection was conducted during the LO₂/LH₂ replenish cycle. LH₂ fast fill started at 2315; LO₂ at 2330. LH₂ topping (from 98%) started at 0123; LO₂ at 0127. The inspection team arrived at the pad at 0145 EST and stayed for approximately 85 minutes.

Comparison of IR gun measurements and computer surface temperature predictions were as follows:

<u>LOCATIONS</u>	<u>IR</u>	<u>COMPUTER</u>
Upper LOX Tank	<u>49.6</u>	<u>47.6</u>
LOX Barrel	46.5	43.9
Intertank	55.0	--
Upper LH ₂ Tank	46.0	42.6
Lower LH ₂ Tank	48.5	45.2

The average ambient temperature was 59.0°F and no acreage ice or frost existed on the ET.

Ice/Frost was present on the LH₂ umbilical baggie and in the recirculation line bellows. The LH₂ baggie had a small tear in the forward outboard corner. No ice or frost was visible in the LH₂ feedline bellows. Ice/Frost fingers had formed on the purge vents.

Ice/Frost accumulation on the LO₂ umbilical baggie and purge vents was typical. A 1 x 3/4-inch frost spot had formed on the LO₂ feedline elbow -Z side.

Ice/Frost was present in the upper and lower LOX feedline bellows, behind all feedline support brackets, and at stations XT 1973/1871 feedline bracket to tank interfaces. Condensate was dripping off the LH₂ tank.

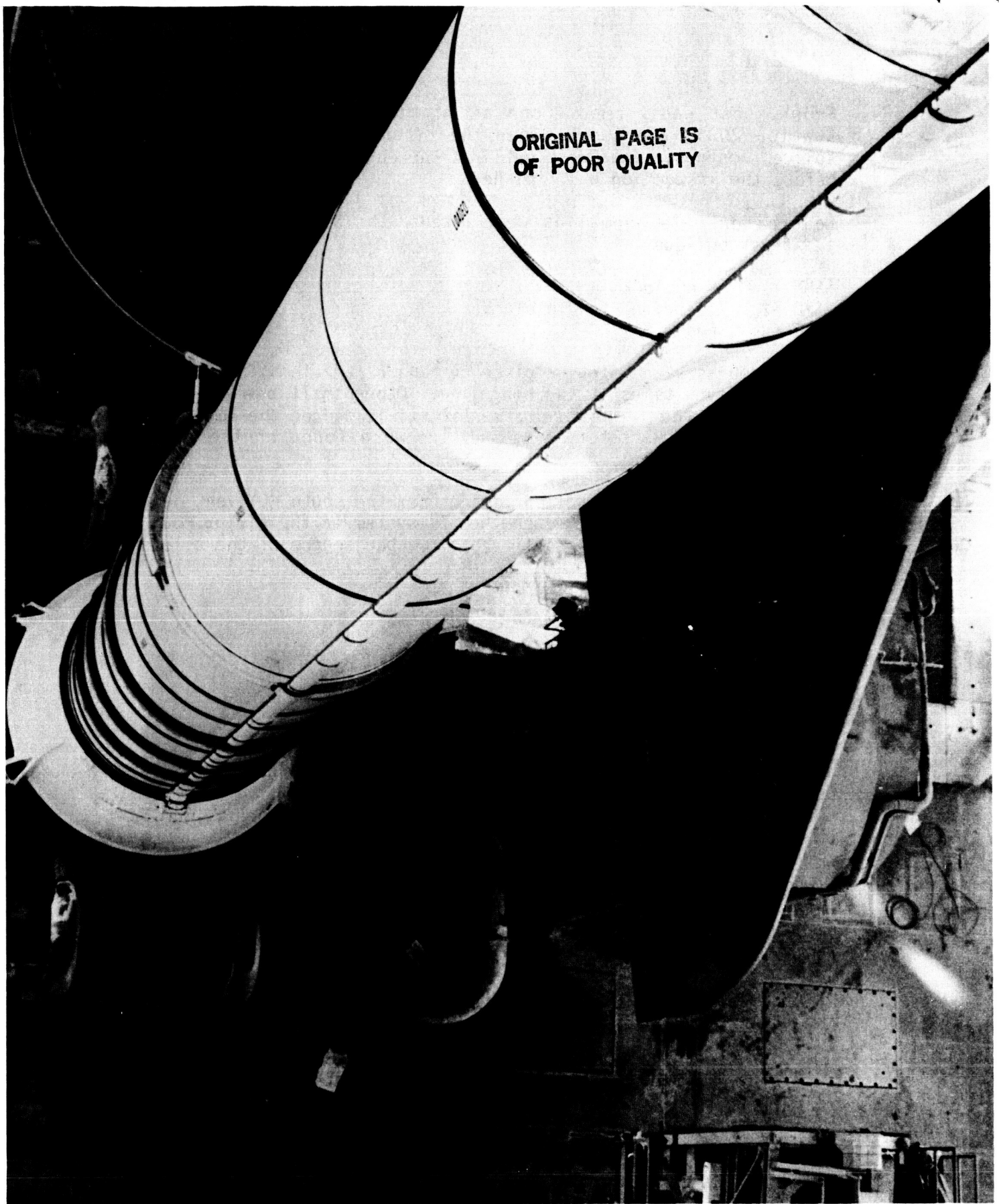
Frost spots had formed - one aft of the pressurization line support at station 2034, and two between the +Y and -Z axis on the LH₂/intertank splice closeout. Ice/Frost outlined the entire PAL ramp, but was melting before the inspection was finished.

No orbiter tile anomalies were noted. The SSME eyeballs had a typical ice/frost buildup:

SSME #1: 5 o'clock
SSME #2: 11 around to 8 o'clock
SSME #3: none

From a debris standpoint, a piece of tape (2 x 2-inch) adhered to the LH orbiter elevon tiles at the hingeline. Other small pieces of tape were observed on the ET lower ogive (-Z side), and on the bottom surface of the RH SRB IEA. A safety rope and sign were found on the entry way to the MLP.

Two 6-8-inch icicles were hanging from the south GOX vent duct. These icicles were later observed on the OTV system in the firing room to break off and fall. They are believed to be the source of the tile damage on the orbiter's LH wing.



Damaged tiles on Orbiter LH Wing. View is from GOX Vent Arm just above ducts where icicles had previously formed.



Three tiles believed to be damaged from icicles falling from GOX Vent Ducts.

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SC007, SHUTTLE LAUNCH COUNTDOWN										HP 41C MODEL RESULTS				DATE: 12/19/86		T-O TIME: ABORT DATE:		N							
SFIS- 32 , (61 - C) , # 1 ABORT (SRB HPF)														ICE TEAM ON PAD: 0145		ICE TEAM OFF PAD: 0310		0							
LO2 TIME		LO2 SLOW FILL TIME: 2316		LO2 FAST FILL TIME: 2330		LO2 SLOW FILL TIME: 2249		LO2 FAST FILL TIME: 2315		ORBITER 102		ET 30		SRB BIO24		MLP 1		PAD 39A							
TIME		REL. HUM. %		DEW PT. °F		WIND VEL. KNTS		WIND DIR DEG.		WIND F-FACTOR		LOCAL VEL. KNTS		SOFTI TEMP °F		'M' COND. RATE IN/HR		ICE RATE IN/HR							
EST		OF																							
GMT																									
0745	55.6	83	50.5	9	315	.59	5.31	44.79	.0018	-.0025	.59	5.31	39.93	.0031	-.0416	.46	4.14	36.3	.0031	-.0189	1.23	11.07	44.97	.0034	-.1187
0800	56.0	83	50.9	10	315	.59	5.90	45.80	.0018	-.0803	.59	5.90	41.33	.0031	-.0529	.46	4.60	37.90	.0032	-.0270	1.23	12.30	46.04	.0033	-.1406
AVERAGES	59.0	74	50	10	NW	.59	5.90	46.95	.0012	-.0877	.59	5.90	42.22	.0025	-.0589	.46	4.50	39.10	.0027	-.0312	1.23	11.70	46.80	.0022	-.1343

STS-32 (61-C)
POST DETANKING INSPECTION
FIRST SCRUB - SRB HPU

The countdown was stopped at T-14 seconds and the launch attempt aborted due to a hydraulic power unit (HPU) turbine overspeed (erroneous measurement) in the RH SRB. No anomalies were observed during detanking of ET-30 (LWT 23).

A Post Detanking Inspection of the pad and Shuttle vehicle was conducted on 19 December 1985. The following items were noted:

- o Expected amounts of ice remained on the LH2 ET/ORB umbilical and purge vents, feedline bellows, and recirc line bellows.
- o The LH2 umbilical baggie was torn (3 inches in length) from the outboard edge toward the Orbiter face and at the aft inboard region.
- o A 2" x 2" piece of tape adhered to tiles at the LH elevon hinge.
- o Two foam defects were present on the LH2 tank/intertank splice 45° between the -Z and +Y axis.

Overall, the External Tank sustained minimal damage and is ready to support a second cryo loading.

STS-32 (61-C)
PRE-FLIGHT VEHICLE/PAD DEBRIS ASSESSMENT
SECOND SCRUB (LOX VALVE)

The STS-32 Pre-Flight Vehicle and Pad Debris Walkdown was repeated 5 January 1986 at 1230 hours. The HPU in the RH SRB had been replaced and hot fired to correct the cause of the T-14 second launch abort of 19 December 1985. Both the vehicle and pad were inspected for potential sources of damaging debris. Photographs were not taken due to continuous rain and the fact that no major items were noted.

No anomalies were observed on the STS-32 stack. The LH lower wing surface and outboard elevon damage, believed to have been caused by ice falling from the south GOX vent duct, had been repaired using TPS-311.

The MLP surface was exceptionally clean with only a few items noted:

- o Scale, foam trimmings, and safety wire in the SRB holddown post well areas.
- o Excess teflon shim on the sound suppression water pipe support north of the RH SRB exhaust.
- o Rope in HDP #6 well.
- o LH SRB primary water bag north of LH SRB not full of water.
- o Zinc-rich scale and foam debris on MLP deck between RH SRB and Orbiter.
- o Tape, decals, zinc-rich scale, and plastic bags in SRB water troughs.
- o Misc items (plastic, paper bag, ID tag) scattered around deck and in handrail post holes.

STS-32 (61-C)
T-3 HOUR ICE/FROST INSPECTION
SECOND SCRUB - LOX VALVE
1/6/86

The vehicle was loaded with cryogenics for a second launch attempt following a T minus 14 second abort on 19 December 1985. This mission was scrubbed at T minus 31 seconds when the replenish valve "CLOSED" signal was not obtained and command logic violations resulted in LO₂ drain through the TSM drain. This caused a negative pressure in the LO₂ tank. After replenishing the propellants, various issues were still unresolved and the mission was scrubbed at the end of the launch window.

On Pad Inspection:	0225 to 0415
Cryos loaded from:	0217 - 0930
Temperature (to scrub)	43 - 57°F, 48.6°F Avg
Winds:	6 - 16 knots, 10 Knt Avg
Relative Humidity:	42 - 87%, 60% Avg
Dew Point:	33 - 44°F, 35°F Avg
SOFI Surface Temp:	23.6 - 45.4°F, 33.9°F Avg

At 0421 a front came through and the weather from 56.7°F/55% RH/6.6 knots from the NE to 45°F/58% RH/5.8 knots from the WNW. Ice in all areas including intermittently on the upper ogive was predicted thereafter until the scrub.

The TPS ice/frost and debris walkdown was conducted during the replenish cycle. LH₂ fast fill started at 2315 (1/5/86); LO₂ fast fill started at 0015, delayed due to valve stem leakage on the replenish valve. The LH₂ tank was in stable replenish at 0140 and the LO₂ tank at 0217. The inspection was started at 0225 for one hour and 50 minutes.

Comparison of IR gun measurements and computer surface temperature predictions were as follows:

	<u>IR GUN</u>	<u>COMPUTER</u>
Upper LO ₂ Tank	41	44.6
LO ₂ Barrel	39	44.2
Intertank	54	N/A
Upper LH ₂ Tank	39.5	35.9
Lower LH ₂ Tank	44.5	50.1

Acreage frost was observed on the LO₂ tank from the +Z axis 20 degrees toward the -Y and between stations 560 to 852. The frost became thicker and more widespread around the tank after the weather front came through the KSC area. After sunrise, most of the frost melted. None was evident by 0900 hours.

The acreage frost on the LH₂ tank, which was observed between the cable tray and right SRB at 0245 hours, had mostly sublimed by 0345. It was instead building at that time on the upper half of the barrel in the other three quadrants (primarily between -Z and -Y). After the front came through, frost occurred generally all over the cryogenic acreage until about 0900 hours.

In the LH₂ umbilical area, ice/frost was typical, but light, on the baggie and purge vents with 2" frost fingers. A 1/2 x 1/4 inch frost spot grew on the recirc line/tank closeout and a 3 x 1 inch frostline formed on the -Y side of the LH₂ feedline/tank closeout.

In the LO₂ umbilical area, ice/frost was also typical and a 3 x 1 inch frostline was present on the feedline elbow. Ice/frost at the F/L bellows and supports (waived areas) was light and, as on the tank acreage, little if any condensate or runoff was present.

A 3 x 1 inch frostline previously observed on the LO₂/LH₂ tank splice closeout between +Y and -Z, reoccurred as did small frost spots on the -Y longeron 3rd hardpoint and aft dome. A new frostline, approximately 8 inches long, formed in the crotch closeout at the +Y thrust strut/longeron interface. Frost also grew on the -Y bipod ramp to tank interface.

Typical frost spots behind some of the LH₂ tank supports and a line of frost down the edge of the PAL ramp occurred. This tank, ET-30, has no ablator panels on the LH₂ barrel (ET-29 had 23 panels).

Small icicles (1 x 1 x 1/2 inch) formed on both GOX vent duct exists (facility arm).

The tumble valve cover was intact in a tightly inward position. It was not replaced for this launch attempt or through the January 12th cryo loading. The hydrogen vent arm was covered with ice/frost.

Both lower EB fittings had ice present. These areas are outside of ice concern region. There was no ice/frost on either lower strut clevis or bolt.

No SRB anomalies were noted.

Frost on the SSME eyeballs was typical. SSME #1 6-8 o'clock; SSME #2 4 around to 2 o'clock; and SSME #3 none present.

SC007, SHUTTLE LAUNCH COUNTDOWN										DATE: 1/5-6/86		T-O TIME: SCRUB DATE: 1/6/86													
STS- 32 , (61 - C) , # 2 SCRUB (LOX FILL/DRAIN VALVE)										ICE TEAM ON PAD: 0225		ICE TEAM OFF PAD: 0415													
LO2 SLOW FILL TIME: 2403 FAST FILL TIME: 0015										LO2 TANK STA 370 TO 540 SLOW FILL TIME: 2253 FAST FILL TIME: 2315		LO2 TANK STA 550 TO 852 SRB B1024 MLP 1 PAD 39A		LO2 TANK STA 1130 TO 1380 ICE TEAM ON PAD: 0225		LO2 TANK STA 1380 TO 2058 ICE TEAM OFF PAD: 0415									
TIME	CONDITIONS				LO2 TANK STA 370 TO 540		LO2 TANK STA 550 TO 852		LO2 TANK STA 1130 TO 1380		LO2 TANK STA 1380 TO 2058														
	TEMP. OF	REL. HUM. %	DEW PT. °F	WIND VEL. KNTS	WIND DIR DEG.	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR					
0700	43.2	87	39.5	7.7	320	.59	4.54	30.9	.0015	+.0052	.59	4.54	31.46	.0013	+.0025	.46	3.54	21.1	.0025	+.0419	1.23	9.47	31.1	.0027	+.0079
0730	42.8	86.8	39.0	8.9	320	.59	5.25	31.4	.0014	+.0031	.59	5.25	31.9	.0013	+.0005	.46	4.09	22.47	.0025	+.0403	1.23	10.95	31.6	.0026	+.0032
0810	46.3	85.5	42.1	9.0	335	.59	5.31	34.99	.0017	-.0142	.59	5.31	35.5	.0015	-.0164	.46	4.14	26.2	.0026	+.0260	1.23	11.07	35.2	.0031	-.0258
0830	48.3	85	43.9	6.0	310	.59	3.54	34.21	.0016	-.0081	.59	3.54	34.9	.0015	-.0103	.46	2.76	23.23	.0024	+.0303	1.23	7.38	33.87	.0031	-.0110
AVERAGE	48.6	60	35	10	NW-ENE	.59	5.9	36.8	.0006	-.015	.59	5.90	34.3	.0000	-.0098	.46	5.40	28.2	.0013	+.0123	1.23	11.1	36.4	.0011	-.0313

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STS-32 (61-C)
POST DETANKING INSPECTION
SECOND SCRUB - LOX VALVE

An inspection of the vehicle and pad was performed by the Ice/Frost/Debris Team on 6 January 1986 following the second attempted launch of STS-32 (61-C). The launch was scrubbed due to an anomaly in a L02 drain valve. This inspection documents and evaluates any TPS damage due to cryo loading/detanking. The inspection was performed from the MLP and FSS using field glasses. The following anomalies were noted:

1. A normal amount of ice/frost remained on the ET/Orbiter umbilical, LH2 feedline bellows and recirculation line.
2. ET foam cracked at the interface of the +Y thrust strut and longeron.
3. Orbiter baggie material separated from the LH2 umbilical for approximately 6 inches along the upper outboard side of the umbilical.
4. Foam on the forward bellows of the ET L02 feedline was cracked and the adjacent tank foam was damaged.
5. ET foam topcoat chipped and abraded from the -Y footprint aft of the GOX vent alignment grid.

All documented ET anomalies met the on-pad acceptance criteria (809-3771). No anomalies were noted on the Orbiter or SRB's.

STS-32 (61-C)
T-3 HOUR ICE/FROST INSPECTION
THIRD SCRUB - TAL WEATHER
1/7/86

The STS-32 stack was loaded with cryogenic propellants for the third launch attempt. The launch was eventually scrubbed due to adverse weather at the Trans-Atlantic abort landing site. At T minus 3 hours in the countdown, the Ice/Frost Team inspected the vehicle.

On Pad Inspection Time :	0138 to 0315, 7 January 1986
Cryos Loaded:	0122 to 1200
Temperature:	64.3 to 68°F
Winds:	4 to 10 knots
Relative Humidity:	58 to 80%
Dew Point:	48 to 59°F
SOFI Surface Temperature:	33.7 to 58.9°F

The TPS Ice/Frost Team Inspection was conducted during the LO₂/LH₂ stable replenish cycle. LH₂ fast fill started at 2309 hours ; LO₂ at 2321 hours. The LH₂ tank was in stable replenish at 0117 and 0055, respectively. The inspection began at 0138 for one hour and 27 minutes. Comparison of IR gun measurements and computer surface temperature predictions were as follows:

	<u>IR GUN</u>	<u>COMPUTER</u>
Upper LO ₂ Tank	55°F	50.°F
LO ₂ Barrel	46.5	43.1
Intertank	64	--
Upper LH ₂ Tank	49.5	34.7
Lower LH ₂ Tank	45°F	50.4°F

Ice/Frost was present on the LH₂ umbilical in the feedline bellows, the recirculation line bellows, and around the upper part of the umbilical. Ice fingers 2-3 inches in length had formed on the purge vents. A frost line on the -Y side of the LH₂ feedline to tank closeout had grown to 6 1/2 inches long. Likewise, frost line had formed on the aft side of the recirc line to tank interface. An Ice/Frost spot (1/2" x 1/4") on the R/L elbow aft (tank) side melted by the end of the inspection. Two Ice/Frost spots (3" x 1/2, 2" x 1") were visible on the -Y vertical strut cable tray closeout. The -Y longeron and thrust strut to tank interface also exhibited Ice/Frost spots.

Ice/Frost was present on the LO₂ umbilical around the upper area and sides. Two inch long ice fingers had formed on the purge vents. A 3 x 1 inch Ice/Frost spot had accumulated on the LO₂ feedline elbow. Ice/Frost was also present in the feedline brackets, upper and lower bellows, and the P/L ramps. The +Y vertical strut tray closeout exhibited a 1 1/2" x 1 1/2" Ice/Frost ball on the aft surface. Ice/Frost spots (1/2" x 1/2", 1/2" x 1/4") were visible on the +Y longeron, as was a 4 x 1 inch frost accumulation on the longeron to thrust strut interface.

Three 1/2 x 1/2 inch frost balls had formed on the aft hardpoint and a fourth spot was visible on the isochem line around a 1 inch diameter rework area.

There was a heavy runoff of condensate from the barrel section, but the LH₂ aft dome was dry. A thin frost line was present on the forward leading edge of the diagonal strut box ramp. Frost outlined that LH₂ tank PAL ramp.

A thin line of frost outlined the -Y bipod ramp. Frost was present in some of the intertank stringer valleys at both intertank flanges on the -Z side.

No orbiter tile anomalies were noted. However, Ice/Frost was observed on the SSME eyeballs:

SSME #1:	6 to 8 o'clock
SSME #2:	3 to 9, 10-11 o'clock
SSME #3:	NONE

From a debris standpoint, a piece of tape was attached to a tile on the speed brake while another piece was found on HDP #2. Protruding shims on the MLP sound suppression stands had not been trimmed.

The only facility problem was a small leak detected at the LO₂ TSM umbilical.

SC007, SHUTTLE LAUNCH COUNTDOWN										DATE: 1/6-7/86		T-O TIME: SCRUB DATE: 1/7/86													
SIS- 32 , (61 - C) , #3 SCRUB (TAL SITE WEATHER)										ICE TEAM ON PAD: 0138		ICE TEAM OFF PAD: 0315													
LO2 SLOW FILL TIME: 2315 FAST FILL TIME: 2321		LH2 SLOW FILL TIME: 2246 FAST FILL TIME: 2309		ORBITER 102		ET 30		SRB BIO24		MLP 1		PAD 39A													
CONDITIONS																									
TIME	TEMP. OF	REL. HUM. %	DEW PT. °F	WIND VEL. KNTS	WIND DIR DEG.	WIND F. FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND F. FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND F. FACTOR	LOCAL VEL. KNTS	SOFT TEMP °F	'M' COND. RATE IN/HR	ICE RATE IN/HR	LH2 TANK STA 550 TO 852	LH2 TANK STA 1130 TO 1380	LH2 TANK STA 1380 TO 2058		
0630	67.0	79	60.4	7	125	.59	4.13	54.54	.0020	-.0996	.59	4.13	49.19	.0035	-.0753	.32	2.24	40.73	.0032	-.0260	1.39	9.73	55.25	.0039	-.1924
0700	67.0	81	61.1	6	125	.59	3.54	54.29	.0021	-.0918	.59	3.54	48.07	.0036	-.0638	.32	1.92	39.07	.0031	-.0195	1.39	8.34	54.66	.0042	-.1663
0730	67.5	82	62.0	7	115	.59	4.13	55.94	.0022	-.1098	.59	4.13	50.41	.0038	-.0813	.32	2.24	41.96	.0034	-.0299	1.39	9.73	56.42	.0043	-.2043
0800	68.0	82	62.5	7	115	.59	4.13	56.49	.0023	-.1128	.59	4.13	50.99	.0039	-.0842	.32	2.24	42.57	.0035	-.0318	1.39	9.73	56.97	.0044	-.2097
0830	68.0	83	62.8	7	110	.59	4.13	56.70	.0023	-.1139	.59	4.13	51.21	.0039	-.0853	.32	2.24	42.78	.0035	-.0325	1.39	9.73	57.19	.0045	-.2119
0840	68.0	81	62.1	4	100	.59	2.36	52.78	.0021	-.0674	.59	2.36	44.41	.0033	-.0387	.55	2.20	42.13	.0034	-.0302	1.22	4.88	51.31	.0042	-.0200
0900	68.0	83	62.8	2	275	.59	1.18	49.68	.0019	-.0449	.59	1.18	41.55	.0031	-.0259	.43	.86	40.21	.0033	-.0223	1.21	2.42	43.78	.0036	-.0371
AVERAGE	66.0	74	58.0	6.8	SE			52.1					45.8					38.4					52.1		

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STS-32 (61-C)
POST DETANK INSPECTION
THIRD SCRUB - TAL WEATHER

The vehicle was inspected on 7 January 1986 approximately 3 hours after detanking was completed. No significant items requiring repair were noted.

The movement at the thrust strut connection to the forward longeron is expected to cause cracks in the foam. Both the +Y and -Y struts have cracks in the crotch area. The -Y side crack goes up the outboard side of the nuckle. The cracks, evident when the ET is still cold (contracted), close when the tank returns to ambient temperature.

A 3-inch long crack was also visible on the -Y side of the feedline bellows at Station 1106. Close visual inspection on 8 January 1986 from the RSS showed bellows motion had crushed a small area, but no material was loose. This is a planned interference to achieve maximum foam thicknesses and avoid ice.

Vapors were emanating from 5 small frost lines on the aft dome apex. At 1530 hours the vapors had stopped and the frost melted suggesting residual LH2 in the tank had boiled off.

Substantial amounts of ice was still remaining on the LH2 ET/Orbiter umbilical.

All documented ET anomalies met the on-pad acceptance criteria (809-3771). No anomalies were noted on the Orbiter or SRB's.

STS-32 (61-C)
PRE-LAUNCH PAD/VEHICLE DEBRIS INSPECTION
FOURTH SCRUB - KSC WEATHER

The RSS was extended to facilitate APU servicing and LH2 engine feedline inspection. Additional inspection from the RSS was accomplished in combination with the debris inspection on 9 January 1986.

The LH2 umbilical baggie has a large tear on the forward outboard corner.

A piece of tape was noted on the inboard side of the L02 feedline forward of Station 1129 support and another piece on the L02 tank -Z axis at Station 760.

Crushed foam on the L02 feedline at Station 1115 support and on the bellows shield at Station 1106 was visually inspected from the RSS. Damage was minor and there was no loose or offset material.

The RSS roof seal at approximately Station 760 had rubbed against the tank causing a 3/4 x 1/2 inch gouge on the tank surface and 4" x 1/2" x 1/4" and 4" x 1" abrasion on the PAL ramp. The RSS roof seal has holes and needs repair/modification.

All documented anomalies on the ET met on-pad acceptance criteria (809-3771) and required no repair.

The pad cleanliness had been maintained and the only new item found was a nut in holddown post #5. Excessive shim material protruded from one sound suppression water pipe support and was trimmed.

STS-32 (61-C)
T-3 HOUR ICE/FROST INSPECTION
FOURTH SCRUB - KSC WEATHER
1/10/86

The STS-32 stack was loaded with cryogenic propellants for the fourth launch attempt. The launch was eventually scrubbed due to heavy and continuous rain in the area until after the launch window expired. However, at T minus 3 hours the Ice/Frost Team inspected the vehicle.

On Pad Inspection Time :	0135 to 0300
Cryos Loaded From:	0119 to 1200
Temperature:	69 to 65°F
Winds:	8 to 19 knots
Relative Humidity:	67 to 90%
Dew Point:	57.8 to 64.1°F
SOFI Surface Temperature:	48.5 to 60.5°F

The TPS Ice/Frost Team Inspection was conducted during the LO₂/LH₂ replenish cycle. LH₂ fast fill started at 2203 hours ; LO₂ fast fill began at 2321 hours. The LH₂ tank and the LH₂ tank were in stable replenish at 0055 and 0119, respectively. The inspection began at 0135 for one hour and 25 minutes. Heavy rainfall occurred during the entire inspection.

Comparison of IR gun measurements and computer surface temperature predictions were as follows:

	<u>IR GUN</u>	<u>COMPUTER</u>
Upper LO ₂ Tank	63°F	60.5°F
LO ₂ Barrel	59	57.3
Intertank	65	--
Upper LH ₂ Tank	57	51.9
Lower LH ₂ Tank	61°F	59.8°F

Ice/Frost was present around the LH₂ umbilical, in the recirculation line bellows, and on the purge vents. Ice/Frost had formed on the LO₂ umbilical purge vents.

Ice/Frost was also present in the LO₂ feedline upper and lower bellows, behind the feedline support brackets, and on the feedline elbow.

Ice/Frost had formed in both the +Y and -Y thrust strut to tank interfaces. A 3/4 inch diameter frost spot was visible on the aft side of the +Y vertical strut to ET/SRB cable tray transition. Ice/Frost balls had accumulated on the aft side of the pressurization line ramp at stations 1974 and 2058.

No acreage ice or frost was observed or predicted.

No orbiter tile anomalies were noted. Ice/Frost was observed on the SSME eyeballs:

SSME #1: 2-5, 6-7, 9-11 O'clock
SSME #2: 2-3, 5-6, 9-11 o'clock
SSME #3: 2-6, 10-11 o'clock

A piece of tape was attached to the -Z side of the LOX ogive at station XT 760.

The small leak in the LOX T-0 umbilical detected on 7 January 1986 had been repaired.

ORIGINAL PAGE IS OF POOR QUALITY

SC007, SHUTTLE LAUNCH COUNTDOWN										DATE:		T-O TIME: SCRUB		DATE: 1/10/86		N	
STS- 32 , (61 - C) , #4 SCRUB (KSC WEATHER)										1/9/86		ICE TEAM ON PAD:		ICE TEAM OFF PAD:		0	
LO2										ORBITER		PAD		MLP		SRB	
SLOW FILL TIME: 2307										102		30		1		BIO24	
FAST FILL TIME: 2321										2303		30		39A		0300	
LO2										WIND DIR		WIND VEL.		WIND FCTR		LOCAL VEL.	
FAST FILL TIME: 2321										DEG.		KNTS		IN/HR		KNTS	
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STS-32 (61-C)
POST DETANK INSPECTION
FOURTH SCRUB - KSC WEATHER

The vehicle was inspected approximately 3 hours after detanking was completed. The following new items or anomalies were noted:

Significant ice remained on the LH2 ET/Orbiter umbilical with a piece 4" x 6" x 18" on the forward surface in the torn baggie area. The part of the baggie in this area was later missing and possibly torn off if the ice fell.

The crack on the -Y thrust strut had lengthened around the top of the nuckle.

One piece of thermal curtain tape had come loose on the -Z side of the LH SRB.

The forward RCS thruster covers were cracked on the forward LH roll thruster, missing on the lower LH roll thruster, and had 1/4, 1/2 and 1 inches of water in the 3 pitch thrusters.

An ice/frost patch (3/4" dia) was venting on the +Z manhole cover.

Expected amounts of ice frost remained in the LH2 feedline/recirc line bellows, as well as the LOX purge vents.

All documented anomalies met the on-pad acceptance criteria (809-3771).

STS-32 (61-C)
PRE-LAUNCH VEHICLE/PAD DEBRIS INSPECTION

The RSS was extended to facilitate additional APU servicing and LH2 engine feedline inspection (after 4 tankings). The GOX vent hood dock seals were also replaced (50 hour use limit + 14 hours extended use). Additional inspection from the RSS was accomplished in combination with the debris inspection on 11 January 1986.

Late night and early morning high winds with gusts to 60 knots delayed various tasks until mid-morning. One item, open from the GOX seal inspection, was footprint topcoat/TPS damage aft of the -Y GOX louver. Bungee cord lanyards, blown by the strong winds, abraded the TPS when the vent hood was not raised for detanking and the dock seals were depressurized. The intent was to keep rain out of the AADS.


The damage was inspected visually and consisted of abrasions 5 x 1, 2 x 3/4, 3 x 3/4, 3/4 x 1/4 and 1/2 x 1/2 inches and erosion 4 x 1-1/2 x 1/4. The area was approved for use "as is" since the damage was located below the dock seal contact area.

The area #1 butcher paper was torn halfway down one side. The LH2 umbilical baggie was partly missing and pulled loose on the -Y outboard side. Close inspection of previous documented anomalies showed no change and required no repair per on-pad acceptance criteria.

The following debris items were noted:

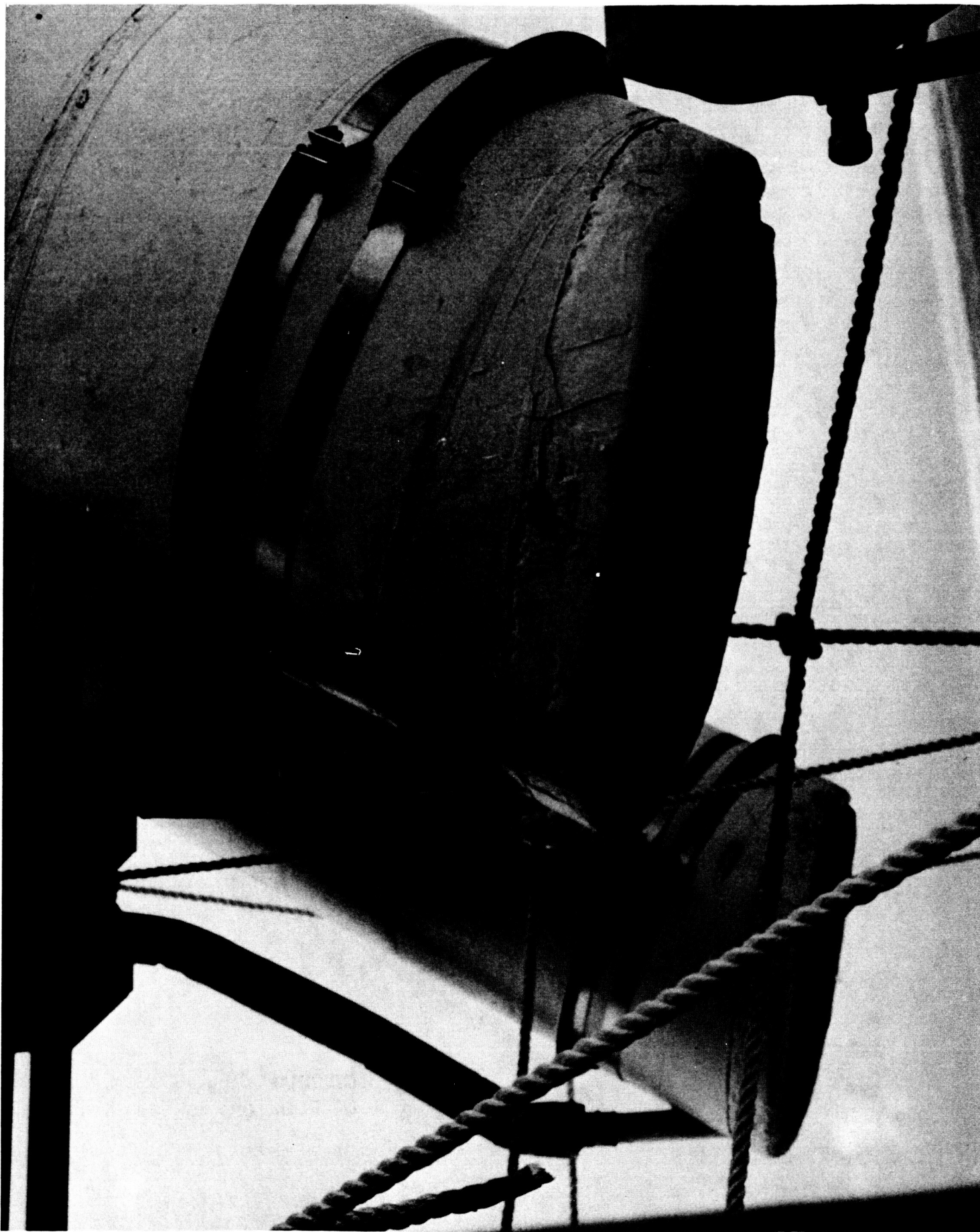
- o Rymple cloth on the ET located approximately 20° in the -Y direction from the +Z axis at station 1300. The cloth was not removed.
- o Piece of tie wrap near the LOX TSM.

Overall, MLP deck and pad cleanliness was excellent.



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Footprint topcoat/TPS damage from windblown bungee cord lanyards



Modifications to GOX Vent Ducts to prevent icicle formation

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STS-32 (61-C)
PRE-FLIGHT DEBRIS INSPECTION
PHOTO REFERENCE

<u>SUBJECT</u>	<u>PHOTO CONTROL NUMBER</u>
AFT DOME	Roll 1 #16
TILES	Roll 1 #13, 14, 17
ET/ORB UMBILICALS	Roll 1 #11, 12, 15 Roll 2 #6, 7, 8
NOSECONE	Roll 1 #3, Roll 2 #0, 1
RCS COVERS	Roll 1 #2, 4-8
RYMPLE CLOTH	Roll 1 #9
SRB THERMAL CURTAIN	Roll 1 #10
GOX DUCT MOD	Roll 1 #18-20, Roll 2 #2
FEEDLINE	Roll 2 #3, 4
THRUST STRUT	Roll 2 #5, 9

STS-32 (61-C)
T-3 HOUR ICE/FROST INSPECTION
LAUNCH
1/12/86

The STS-32 stack was tanked for the 5th time and launched at 0655 hours. At T minus 3 hours, the Ice/Frost Team inspected the vehicle:

On Pad Inspection Time :	0115 to 0340, 12 January 1986
Cryos Loaded:	0106 to 0655
Temperature:	55 to 65°F
Winds:	8 to 15 knots
Relative Humidity:	50 to 75%
Dew Point:	42.5 to 55.2°F
SOFI Surface Temperature:	33.1 to 54°F

The TPS Ice/Frost Team Inspection was conducted during the LO₂/LH₂ replenish cycle. LH₂ fast fill started at 2251 hours (1/11/86), LO₂ at 2308 hours. The LH₂ tank was in replenish at 0035 and the LO₂ tank at 0106. The inspection was started 0115 for two hours and 25 minutes. On Pad time was extended to remove icicles from the south GOX vent hood duct.

As a result of tile damage during the December 19th tanking an icicle net was fabricated. The icicles were successfully removed and captured.

Comparison of IR gun measurements and computer surface temperature predictions were as follows:

	<u>IR GUN</u>	<u>COMPUTER</u>
Upper LO ₂ Tank	53°F	50.1°F
LO ₂ Barrel	60	42.4
Intertank	60	--
Upper LH ₂ Tank	44	43.3
Lower LH ₂ Tank	52°F	47.9°F

No acreage ice/frost was observed or predicted. Anomalies on the vehicle after 5 cryogenic loadings were minor:

Ice/Frost on the LH₂ umbilical was heavier than normal, especially on the -Y side where the baggie was torn and some was missing.

Ice/Frost fingers at the purge vents were typical.

The LH₂ feedline has a 6-inch long frost line at the feedline to tank closeout and a 3/8-inch diameter frost spot on the feedline.

Ice in the LO₂ feedline bellows, at the feedline supports, in the LH₂ feedline bellows and recirculation line bellows was typical.

A 3 X 1-inch frost area on the -Z side of the LO₂ feedline elbow was the same as prior inspections.

Frost on the aft press line ramp to tank interface was evident at support stations 1528, 1657, 1722, 1787, 1916, 1980, 2023, and 2058.

Frost was starting to build at the -Y thrust strut to longeron interface (cracked area) and 2 each 3/4-inch diameter frost balls were noted on the longeron closeout.

Two 3/8-inch frost spots were on the third hardpoint closeout and a 1/4-inch frost spot was on an adjacent plug pull repair.

On the aft dome, 3 frost spots were noted on the +Z manhole cover and 4 frost spots in the apex closeout.

One inch diameter frost balls had formed aft of the +Y and -Y vertical strut to tank closeout and the adjacent -Y cable tray ramp foam.

The +Y thrust strut/longeron crotch had thick ice/frost approximately 4 x 3/4-inch in the cracked area and five frost areas on the adjacent longeron closeout. One frost line (6-inch long) was associated with a 12-inch long crack. There was no offset and the defect was in an area insensitive to ascent heat or critical/probable orbiter damage. The defect was acceptable for flight.

The PAL ramp edges and roots of intertank stringers (-Z area) had light frost which melted. Condensate was very light and there was no runoff. There was a light frost line at the -Y bipod ramp and frost spots on the LH₂/intertank splice closeout 20 degrees left of the +Z axis and 50 degrees left of -Z axis.

All of the frost spots/frostlines and waived ice areas on the external tank were typical of previous missions and were not a concern to the mission.

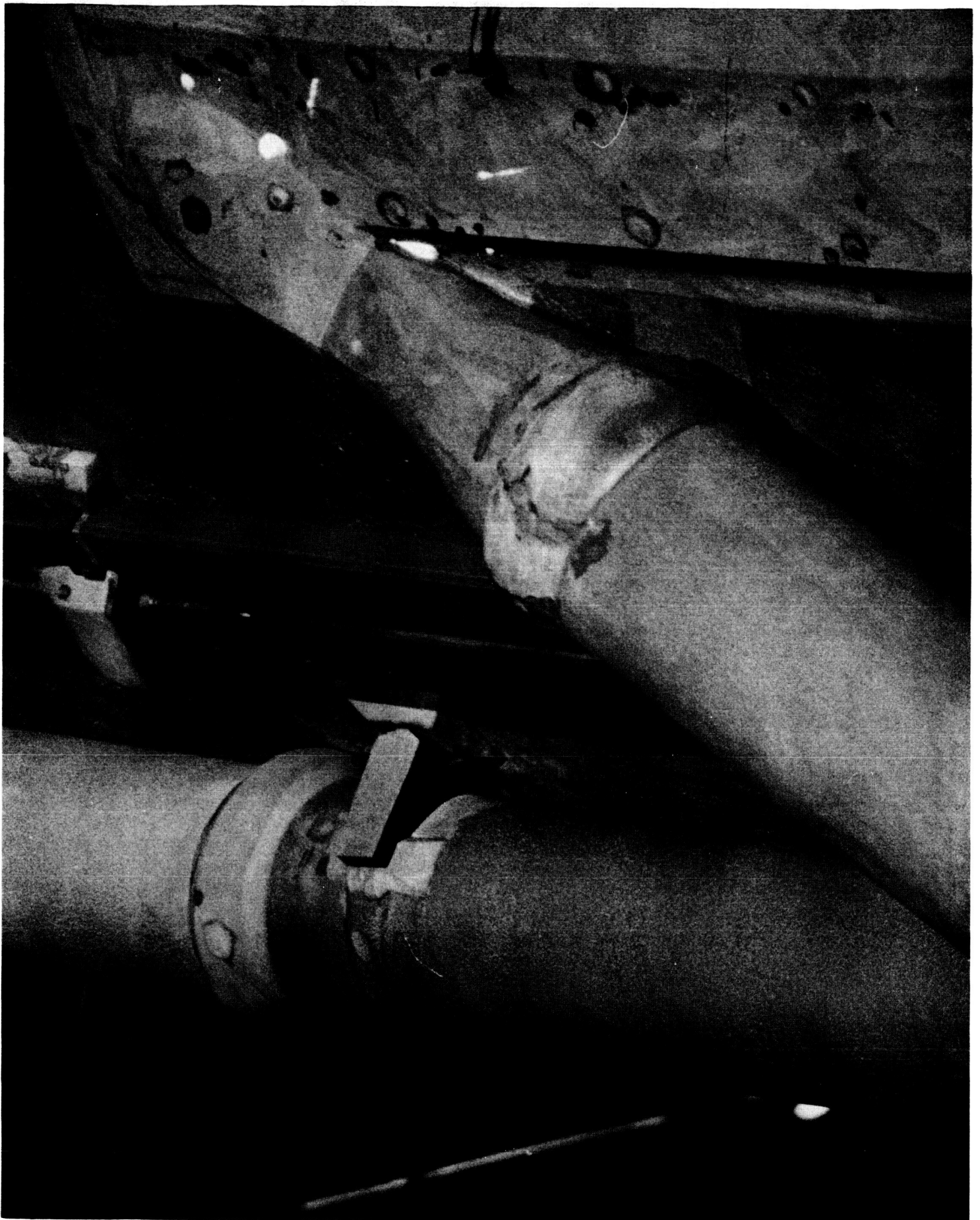
There was a piece of rymple cloth on the ET barrel section at Station 1300 about 20 degrees left of the +Z axis and a piece of tape at Station 760 on the -Z axis. These items were not removed for flight.

A piece of thermal tape was loose on the LH SRB aft skirt. A piece of tape was present on the RH SRB IEA and was not removed before flight.

The only orbiter tile anomaly was a protruding gap filler below (aft) of the crew hatch.



Protruding tile gap fillers below Crew Hatch.



Ice/Frost spots on longeron to thrust strut interface

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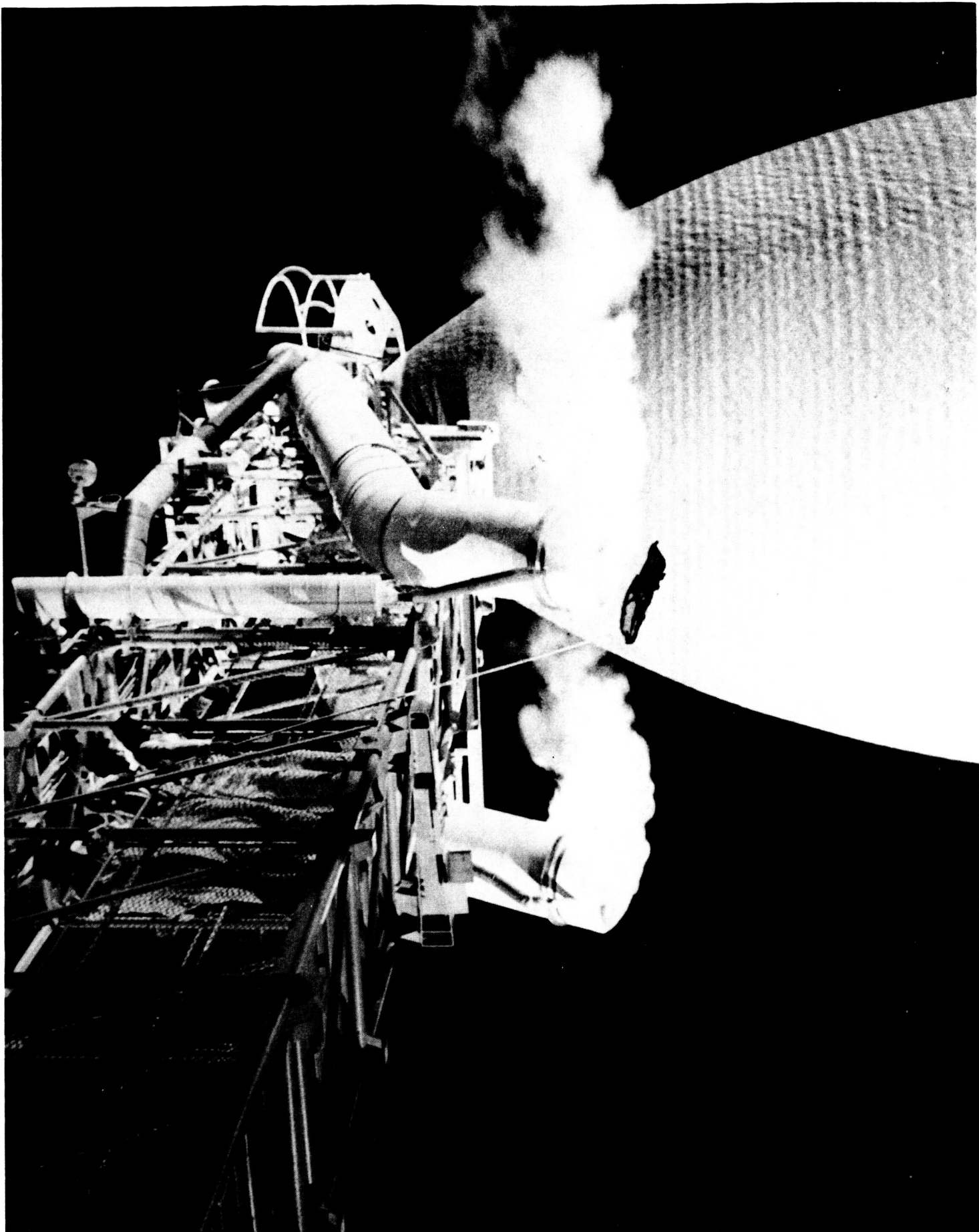
Frost formation on +Y longeron TPS crack

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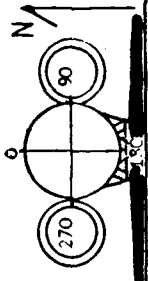
Icicles on south GOX Vent Duct

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Removal of icicles using specially fabricated "Shrimp Net"

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50007, SHUTTLE LAUNCH COUNTDOWN STS- 32 , (61 - C) , # 5 LAUNCH										HP-41 PROGRAM				DATE: 1/11-12/86				T-O TIME: 6:55 EST DATE: 1/12/86																															
LO2 SLOW FILL TIME: 2255 FAST FILL TIME: 2308						LH2 SLOW FILL TIME: 2227 FAST FILL TIME: 2251						ORBITER 102 ET 30				SRB B1024 MLP 1 PAD 39A				ICE TEAM ON PAD: 0115 ICE TEAM OFF PAD: 0340																													
CONDITIONS										LO2 TANK STA 370 TO 540										LO2 TANK STA 550 TO 852										LH2 TANK STA 1130 TO 1380										LH2 TANK STA 1380 TO 2058									
TIME EST GMT	TEMP. OF	REL. HUM. %	DW PT. OF	WIND VEL. KNTS	WIND DIR DEG.	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR	WIND FACTOR	LOCAL VEL. KNTS	SOFT TEMP OF	'M' COND. RATE IN/HR	ICE RATE IN/HR									
2300	64	73	55.3	15	0	.59	8.85	II 53.97	.0008	-.1688	.59	8.85	II 50.62	.0027	-.1386	.44	6.6	II 47.85	.0032	-.0936	.99	14.8	II 53.15	.0021	-.2401																								
2330	65	62	51.8	13	0	.59	7.67	I 52.32	.0000	-.1361	.59	7.67	II 48.24	.0017	-.1068	.44	5.7	II 45.22	.0022	-.0693	.99	12.8	II 50.99	.0006	-.1881																								
2400	65	53	47.5	15	30	.59	8.85	I 53.17	.0000	-.1382	.59	8.65	II 47.11	.0002	-.1093	.44	6.6	II 44.41	.0011	-.0714	.99	14.8	I 51.57	.0000	-.1937																								
0030	65	52	47.0	13	30	.59	7.67	I 52.03	.0000	-.1183	.59	7.67	II 46.09	.0004	-.0911	.44	5.7	II 42.91	.0012	-.0562	.99	12.8	I 50.10	.0000	-.1617																								
0100	64	51	45.5	12	45	.59	7.08	I 48.27	-.0011	-.1013	.59	7.08	II 44.29	.0005	-.0742	.70	8.4	II 44.83	.0003	-.0879	1.21	14.52	I 50.39	.0000	-.1726																								
0130	63	50	44.0	11	40	.59	6.49	I 48.54	.0000	-.0850	.59	6.49	II 42.40	.0005	-.0584	.70	7.7	II 42.35	.0006	-.0656	1.21	13.31	I 47.87	.0000	-.1391																								
0200	64	53	46.6	10	25	.59	5.90	I 49.77	.0000	-.0877	.59	5.90	II 43.33	.0010	-.0600	.70	7.0	II 43.26	.0012	-.0670	1.21	12.10	I 47.83	.0000	-.1403																								
0230	64	53	46.6	9	25	.59	5.30	I 47.38	-.0002	-.0779	.59	5.30	II 42.42	.0011	-.0511	.70	6.3	II 43.01	.0012	-.0608	1.21	10.9	I 47.42	.0000	-.1273																								
0300	65	55	48.6	12	25	.59	7.08	I 50.14	-.0007	-.1145	.59	7.08	II 46.22	.0009	-.0870	.70	8.4	II 46.74	.0008	-.1024	1.21	14.52	I 51.43	.0000	-.1956																								
0330	65	55	48.6	13	10	.59	7.67	I 52.12	.0000	-.1237	.59	7.67	II 46.79	.0008	-.0962	.44	5.7	II 43.61	.0015	-.0602	.99	12.8	I 50.16	.0000	-.1697																								
0400	64	54	47.1	10	20	.59	5.90	I 48.92	.0000	-.0882	.59	5.90	II 43.56	.0011	-.0613	.44	4.4	II 39.84	.0016	-.0336	.99	9.9	II 46.66	.0002	-.1150																								
0430	64	60	49.9	10	10	.59	5.90	II 49.46	.0002	-.0966	.59	5.90	II 44.71	.0017	-.0679	.44	4.4	II 41.19	.0021	-.0397	.99	9.9	II 48.04	.0011	-.1272																								
0500	63	58	49.0	10	40	.59	5.90	II 47.86	.0001	-.0846	.59	5.90	II 43.22	.0015	-.0594	.70	7.0	II 44.46	.0017	-.0748	1.21	12.1	II 48.26	.0005	-.1511																								
0530	64	58	49.0	10	40	.59	5.90	I 49.08	.0000	-.0938	.59	5.90	II 44.25	.0016	-.0653	.70	7.0	II 45.04	.0018	-.0786	1.21	12.1	II 48.79	.0002	-.1565																								
0600	65	60	50.9	10	20	.59	5.90	II 50.46	.0002	-.1028	.59	5.90	II 45.75	.0018	-.0740	.44	4.4	II 42.26	.0022	-.0447	.99	9.9	II 49.03	.0011	-.1360																								

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STS-32 (61-C)
ICE FROST INSPECTION
PHOTO REFERENCE

<u>ORBITER</u>	<u>PHOTO CONTROL NUMBER</u>
OVERALL VIEWS	Roll 1: #2,4,5,14,17,21
TILES	Roll 1: #7,8,10,15,16 Roll 2: #13,15,21
T-O UMBILICAL	Roll 1: #12,13 Roll 2: #3,5,6,9,10
SSME	Roll 1: #23-29
OMS POD	Roll 2: #26
GAP FILLER	Roll 3: #29-31
 <u>EXTERNAL TANK</u>	
E/T OVERALL	Roll 1: #3,20
AFT DOME	Roll 1: #6 Roll 2: #2
UMBILICALS	Roll 1: #11 Roll 2: #1,11,14,30,36,37
GH ₂ VENT ARM, GUCP	Roll 1: #18 Roll 2: #16,29
GOX VENT ARM, DUCTS	Roll 1: #19,22 Roll 2: #19,20,22,23,27,28 Roll 4: #6A,7A,20A
ICICLE RETRIEVAL	Roll 1: #31-35
THRUST STRUTS	Roll 2: #4,8,12,31,32
INTERTANK	Roll 2: #7,24 Roll 3: #25 Roll 4: #4A,5A
BIPODS	Roll 2: #17,18

PRESSLINE

Roll 2: #25

FEEDLINE

Roll 2: #33-35

Roll 3: #23,24,33

Roll 4: #16A,17A, 18A

LONGERON

Roll 3: #16-19

NOSECONE

Roll 4: #0B,0A,3A

EB FITTING

Roll 4: #8A

SRB

AFT SKIRT

Roll 1 #9

STS-32 (61-C)
POST LAUNCH PAD DEBRIS INSPECTION

A post launch inspection of Pad 39A was conducted by the Debris Team on 12 January 1986 at T+1 hour 15 minutes. The FSS, MLP, pad apron and acreage areas were inspected for vehicle damaging debris or flight hardware which might have fallen off during launch.

No significant flight hardware from any of the Shuttle elements was found except for a corner of a white tile (3 x 1 1/2 inches). This piece, found on the southeast slope of the pad apron, came from the orbiter vertical stabilizer. Three FRSI plugs from the Orbiter base heat shield carrier panels and five pieces of black tile gap filler were scattered north and east of the pad. Three small pieces of SSME nozzle ramp insulation were also found.

Several small pieces of foam similar to that used on the ET and SRB's lay in the grass area of the pad. They were weathered and appeared to be trimmings from flight hardware closeouts at the pad.

The usual amount of SRB throat plug, RTV, SRB overpressure water troughs, small nuts and bolts, and other typical launch debris items were found.

Six pieces of SRB holddown post shim material were found to the north and east of the pad and in the flame trench. The shim material appeared to be aged and is probably from a previous launch.

Shim and sidewall material was intact on all of the south holddown posts. Four pieces of fragile nut and four NSI fragments were found in the bolt holes in the south holddown posts. These fragments should have remained in the SRB aft skirt HDP blast covers. The north holddown posts sustained typical erosion.

Most of the excessive RTV used on the HDP belly bands had either blown away or melted and dripped.

Grouting around the base of the TSM's was cracked with large pieces separated from the TSM walls.

A band on the sound suppression water pipe adjacent to HDP #4 broke loose.

Six bolts on the MLP deck were loose.

A facility weather vane from the FSS southwest corner was found. The vane lay on the NW corner of the MLP while the shaft and weight was discovered in the flame trench under the north diverter.

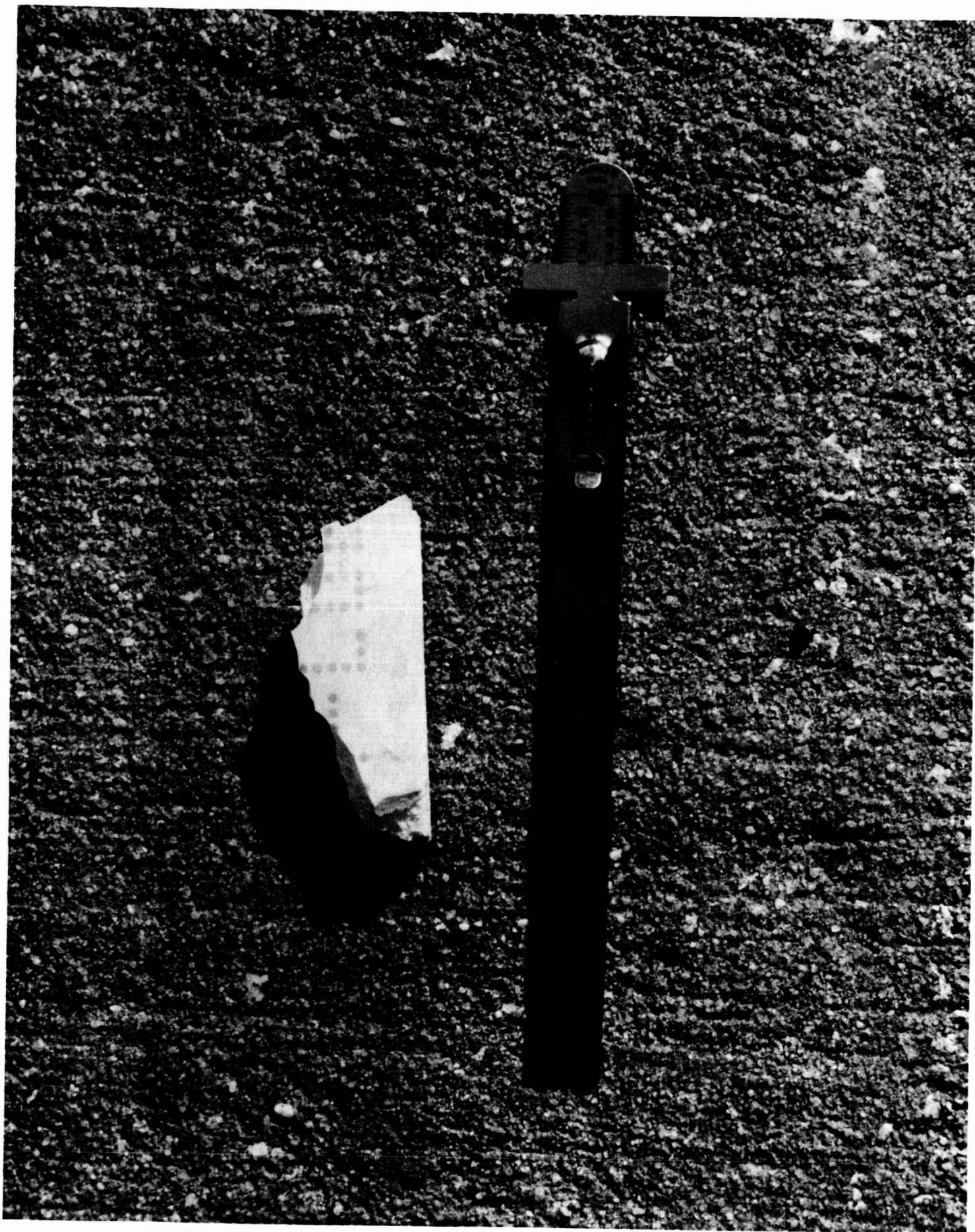
The ET GH₂ vent arm functionedd properly and sustained no damage. It latched on the second tooth.

The debris inspection of Pad 39A was expanded on Monday, January 13th 1986, to include aerial surveillance by helicopter of inaccessible areas and the beach. The helicopter flyover was conducted for two hours and the search pattern included the beach, road, and railroad tracks from Playalinda to the Cape Canaveral lighthouse, a sweep of the ocean up to one mile off-shore, the area between Pad A and Pad B from the crawlerway to the beach, the area between Pad A and Complex 41 and the ground west of Pad A.

The beach walkdown was conducted for three hours from Playalinda Beach to Complex 40 using a four-wheel drive vehicle.

Five pieces of aged and weathered ET foam were discovered. The following table and map documents physical characteristics and location:

<u>SAMPLE</u>	<u>SIZE (INCHES)</u>	<u>KNIT LINES</u>	<u>RIND</u>
1	4 x 2 1/2 x 1 1/4	4	No
2	2 3/4 x 1 1/4 x 5/8	2	No
3	2 1/4 x 1 3/4 x 1/2	0	No
4	3 1/4 x 1 1/2 x 3/4	2	No
5	9 1/2 x 2 1/2 x 1	2	?



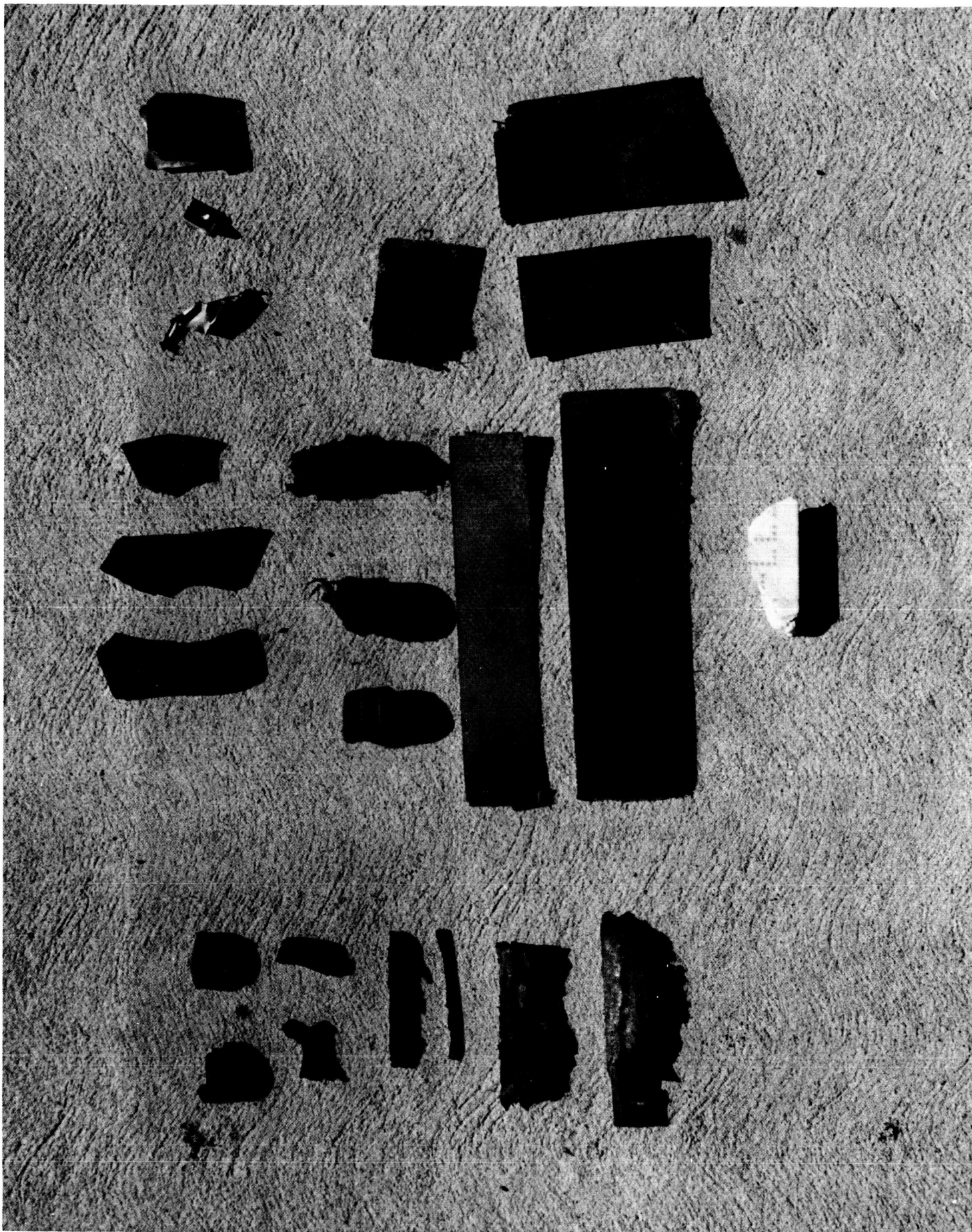
Piece of tile found on pad apron southwest slope

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Post Launch Pad Inspection - typical facility debris

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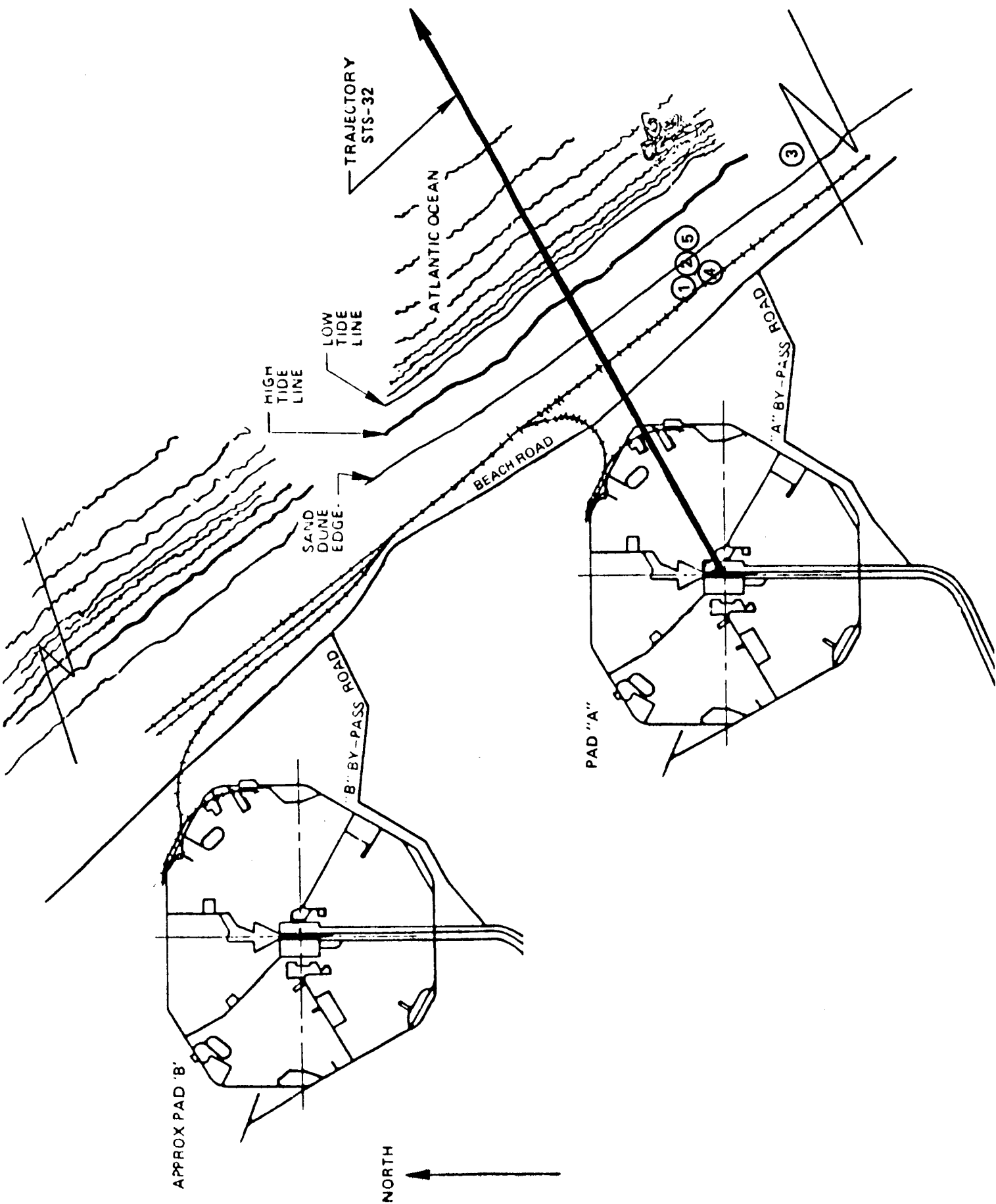


Post Launch Pad Inspection - flight hardware debris

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Post Launch Pad Inspection - foam and ablator samples



POST LAUNCH DEBRIS WALKDOWN

STS-32 (61-C)
POST LAUNCH PAD DEBRIS INSPECTION
PHOTO REFERENCE

<u>SUBJECT</u>	<u>PHOTO CONTROL NUMBER</u>
PIECES OF WHITE TILE	Roll 1: #2,3
DEBRIS, OVERALL	Roll 1: #25
DEBRIS, FLIGHT	Roll 1: #26 Roll 2: #9,10
NORTH HOLDDOWN POSTS	Roll 1: #4,5,14-17
SOUTH HOLDDOWN POSTS	Roll 1: #6-9
FRANGIBLE NUT FRAGMENTS	Roll 1: #10
MLP DECK BOLTS	Roll 1: #11
TSM GROUTING	Roll 1: #13,19,20
WATER PIPE BRACKET	Roll 1: #18
MLP DECK, OVERALL	Roll 1: #21
LH ₂ VENT ARM, GUCP	Roll 1: #22-24

STS-32 (61-C)
FILM REVIEW
SUMMARY

A detailed review of STS-32 (61-C) launch films was conducted between 13 January and 15 January 1986. No major vehicle damage or anomalies were observed. The following observations were made:

1. The usual ice-fall occurred from the GH₂ vent arm, GUCP, ET/Orbiter umbilicals and baggies, SSME's, and T-0 umbilicals.
2. Numerous pieces of SRB throat plug and MLP deck scale were ejected from the SRB flame holes at SRB ignition and immediately after liftoff.
3. SRB thermal curtain tape was loose at liftoff.
4. Aft RCS cover paper ruptured and tore off after SSME ignition. Forward RCS cover paper stayed intact at least through tower clear.
5. Ice falling from GH₂ vent arm impacts Orbiter wing leading edge RCC.

STS-32 (61-C)
POST LAUNCH FILM REVIEW

E-1 Camera is located on the NE corner of the MLP deck and views the
400 FPS lower ET, SRB's and Orbiter.

1. GH2 vent arm ice falls parallel to SRB.
2. 6"x6" flat object falls along right wing corner surface.
3. One dark object comes from RSRB hole at high speed and passes in front of ET.

E-2 Camera is located on the SE corner of the MLP deck and views
400 FPS Orbiter SSME and OMS engine nozzles.

1. Underexposed.
2. Five flat debris objects seen falling and 3 flat debris objects thrown upwards from RSRB hole. The following 6 particle sizes were noted: 3"x8", 3"x5", 4"x8", 4"x9", 4"x5"
3. Ice falls from LO2 TSM.
4. RCS paper covers were gone by the time sufficient lighting was available for viewing this area.

E-3 Camera is located on the SW corner of the MLP deck and views
400 FPS Orbiter SSME and OMS engine nozzles.

1. RCS paper cover falling.
2. Film underexposed.
3. LSRB thermal curtain tape loose.
4. Seven pieces of ice fall from SSME.

E-4 Camera located on the NW corner of the MLP deck and views
400 FPS lower ET, SRB's, and Orbiter.

1. GH2 vent arm ice falling.
2. ET/Orb LO2 umbilical ice falling.
3. One high speed particle thrown from RSRB hole in vicinity of HDP #4.
4. Loose tape on SRB thermal curtain.
5. Four pieces of ice fall from vicinity of SSME #3.

E-5 Camera is located on the east side of the MLP deck and views the
400 FPS Orbiter RH wing, body flap, and lower ET/SRB.

1. Debris object (6"x12") falls between SSME #2 and #3 and body flap. Second object (6"x2") falls past north side of body flap.
2. Much data missed due to underexposed film.
3. Several pieces of ET/ORB umbilical ice seen falling.
4. A total of 9 pieces fall from wing area. Largest piece is 6" x 2". The other pieces are approximately 2"x2".
5. Loose thermal curtain tape.

- E-9
400 FPS Camera is located on MLP deck and views the RH SRB SW holddown post (HDP) #1.
1. Ice from ET/ORB falls to deck and blows around.
 2. Dark flat object (2"x5") passes in front of RSRB at high rate of speed and goes into SSME hole.
 3. Particles seen in film "E5" are seen again.
- E-12
400 FPS Camera is located on the MLP deck and views the LH SRB SE HDP #5
1. Loose SRB thermal curtain tape.
 2. Film underexposed and part of data lost.
 3. Ice particles moving across deck.
- E-19
400 FPS Camera is located on the SE side of the MLP deck and views the SSME/OMS nozzles and Orbiter aft heat shield area.
1. RCS paper covers falling.
 2. Considerable amount of L02 T-0 umbilical ice falls.
 3. Ice falls from SSME #1 overboard L02 drain.
- E-20
400 FPS Camera is located on the SW side of the MLP deck and views the SSME/OMS nozzles and Orbiter aft heat shield area.
1. Tile gap filler comes out of left RCS stinger area.
 2. RCS paper covers falling.
 3. Ice from SSME nozzles and LH2 T-0 umbilical seen falling.
- E-25
400 FPS Camera is located on the east side of the MLP and views between Orbiter and ET/SRB during liftoff to show possible debris.
1. Important data lost due to overexposure of film.
 2. Ice falls from both ET/ORB umbilicals starting at SSME ignition and continues falling through liftoff.
 3. Gap filler falls past north side of TSM (2"x8").
 4. At least 20 flat rectangular objects (2"x2" and greater) fall from area of right aft fuselage and upper inboard elevon.
 5. Same particles observed in camera E5 near SRB observed again.
 6. Large dark flat object (6"x6"x1") falls from aft heat shield near SSME #3 nozzle.
- E-26
400 FPS Camera is located on the west side of the MLP and views between Orbiter and ET/SRB during liftoff to show possible debris.
1. Twelve large particles believed to be from GH2 vent line pass by body flap and LH elevon. Three largest particles are: (2) 6" x 18" and 6" x 10".
 2. Particles falling from ET/Orbiter umbilicals.
 3. Loose LH SRB thermal curtain tape.
 4. One (approx. 2" diameter) high speed particle traveling from "E-26" towards SSME #1.

E-34 Camera is located on FSS at 255 foot level and views upper
400 FPS Orbiter tile surface.

1. Much data lost due to film overexposure.
2. Piece of cheese cloth on ET at liftoff remains in place throughout film.
3. Normal separation of GUCP from ET.
4. Forward RCS paper covers (which were replaced between 4th and 5th launch attempt) remained intact.

E-35 Camera is located on the FSS 255 foot level and views the
400 FPS mid-Orbiter/ET/SRB area.

1. Much data lost due to overexposure film.
2. Several large pieces of ice falling from GH2 vent arm toward left wing.
3. Three pieces of ice/frost from GUCP fall between LSRB and ET and possibly impact lower left wing.

E-36 Camera is located on the FSS 255 foot level and views lower
400 FPS Orbiter, ET, SRB's and water trough area.

1. Six large pieces (maximum 24"x9") of ice/frost fall from GH2 vent arm. One piece (approx. 18"x9") impacts the left wing leading edge RCC. Two pieces narrowly miss aft portion of left wing lower surface. Another hits LSRB ET ring. Two others pass between Orbiter left wing and LSRB.

E-40 Camera located FSS 255 east side and views ET OGIVE, SRB nosecone
400 FPS and tiled surfaces of Orbiter passing through frame.

1. Piece of cheese cloth still attached to ET surface.
2. Much data lost due to overexposure film.
3. Forward RCS paper covers on left side still intact.

E-76 Camera is located on camera site 3 on the SE corner of the pad
400 FPS perimeter by the pad gate. It views SSME engine #1 and #3 and the +Y OMS nozzle.

1. Did not run.

E-77 Camera is located on camera site 4 on the SW corner of the pad
200 FPS perimeter just west of the pad gate. It views SSME engine #1 and #2 and the -Y OMS nozzle.

1. Ice falling off T-0 TSM, engine nozzles, umbilicals.
2. Butcher paper falling off aft RCS nozzles.

- E-6 Camera is located on the east side of the MLP deck and views the
200 FPS RH lower Orbiter wing, body flap, and ET/Orbiter umbilical area.
1. Many particles referred to in E-2, E-5, and E25 are visible (approximately 27 pieces).
 2. Film underexposed.
- E-15 Camera is located on MLP deck and views the RH SRB skirt, sound
400 FPS suppression water troughs, and RH lower Orbiter body flap.
1. Film underexposed.
 2. As vehicle rises, upward surge of flame seen at HDP #4 traveling to HDP #3.
 3. Aft ring of aft skirt was burning.
- E-16 Camera is located on the MLP deck and views the LH SRB skirt, sound
400 FPS suppression water troughs, and LH lower Orbiter body flap.
1. Film underexposed.
 2. Thermal tape between HDP 7 and 8 is loose.
 3. Flame seen coming up HDP #7.
 4. GH2 vent arm ice seen falling around Right and left sides of SRB.
 5. GH2 vent arm adjacent to Orbiter body flap, possibly from umbilicals.
- E-30 Camera is located on the FSS 135 foot level and views LH SRB
400 FPS and sound suppression water troughs.
1. Film underexposed.
 2. Ice falling from GH2 vent arm down into SSME hole.
- E-31 Camera is located on the FSS 95 foot level and views the LH
100 FPS Orbiter wing, body flap, and ET/Orbiter LH₂ umbilical area.
1. Film underexposed.
 2. Large piece of ice (4"x24") seen falling from ET/Orb umbilical at T-0.
 3. Many large pieces of ice falling from GH2 vent arm of which largest piece is 6"x24". Nine pieces hit lower Orb wing surface and lower elevon surface.
 4. Piece of gap filler is observed shaking out of inboard elevon lower surface.
- E-32 Camera is located on the FSS 195 foot level and views the Orbiter
400 FPS LH OMS pod, TSM, LH SRB, and sound suppression water troughs.
1. Loss of data due to underexposure film.
 2. Ice falls from GH2 vent arm.
 3. Loose thermal curtain tape.

E33 Camera is located on the FSS 235 foot level and views the ET GH₂
400 FPS vent line and GUCP.

1. Adequate film exposure.
2. Twang effect visible.
3. Normal GUCP separation - no loss of ET TPS.
4. Ice/frost falls from GH₂ vent arm at GUCP separation.

E-52 Camera is located at camera site 2 on the east pad perimeter.
100 FPS Remote tracking of lower one-third of launch vehicle from
 ignition to 1200 feet.

1. Total loss of data due to inadequate exposure of film.

E-53 Camera is located at camera site 2 on the east pad perimeter.
100 FPS Remote tracking of middle one-third of launch vehicle from
 ignition to 1200 feet.

1. Several pieces of ice seen falling from ET/Orb umbilicals.
2. Poor exposure of film.
3. Fwd RH RCS butcher paper appears to be intact.

E-54 Camera is located at camera site 2 on the east pad perimeter.
100 FPS Remote tracking of upper one-third of launch vehicle from
 ignition to 1200 feet.

1. Film underexposed.

E-79 Camera located at camerasite 2 on the east pad perimeter and
100 FPS views ET nose cone.

1. Was not committed for night operations.

E-214 Close in view of entire launch vehicle during ignition, liftoff
32 FPS and early portion of flight through LOV.

1. Film underexposed.

E-215 Close in view of entire launch vehicle during ignition, liftoff,
32 FPS and early portion of flight through LOV.

1. Film broke.

E-7
400 FPS

Camera located on the MLP deck and views the RH SRB NE HDP #4.

1. Two pieces of shrapnel fall out of aft skirt bolt hole and a third piece of material fell from the outboard side of the shoe (probably shim).
2. The shim remained intact on the aft skirt shoe.
3. Three pieces of instafoam observed falling from aft skirt ring.
4. Ice falls from GH2 vent arm.
5. Film underexposed.

E-8
400 FPS

Camera is located on the MLP deck and views the RH SRB SE HDP #2.

1. One piece of shrapnel falls out of aft skirt bolt hole.
2. Two pieces of thermal curtain tape loose.
3. Several pieces of SRB throat plug material thrown upwards.
4. Sound suppression water is thrown upwards and impacts nozzle and thermal curtain.
5. Film underexposed.

E-10
400 FPS

Camera is located on the MLP deck and views the RH SRB NW HDP #3.

1. Film underexposed.
2. Two fragments fell from blast container area.
3. RTV portion of throat plug flies out of SRB hole.

E-11
400 FPS

Camera is located on the MLP deck and views the LH SRB NE HDP #7.

1. Film underexposed.
2. Loose thermal curtain tape.
3. One fragment falls out of blast container area.
4. Three small pieces of instafoam fall from aft ring.
5. Ice from ET umbilical area hits MLP deck.

E-13
400 FPS

Camera is located on the MLP deck and views the LH SRB SW HDP #6.

1. Film underexposed.
2. Loose thermal curtain tape.
3. Considerable amount of debris on MLP deck (ice and other unknown items).

E-14
400 FPS

Camera is located on the MLP deck and views the LH SRB NW HDP #8.

1. Film underexposed.
2. Loose thermal curtain tape.
3. One fragment falls out of blast container opening.
4. Ice from GH2 vent arm falls on MLP deck.

- E-17 Camera is located on the MLP deck and views the TSM L02 T-0
400 FPS umbilical.
1. Three gap fillers seen falling past lower surface of right inboard elevon.
 2. Considerable ice falls from ET/Orb umbilicals and L02 T-0 umbilical.
 3. RCS covers blown off.
 4. Motion of fabric around SSME #3 observed.
 5. Film underexposed.
- E-18 Camera is located on the MLP deck and views the TSM LH2 T-0
400 FPS umbilical.
1. Film underexposed.
 2. Ice from ET hydrogen umbilical.
 3. Butcher paper on aft RCS nozzle tears.
 4. One gap filler shim travels from left to right across screen.
- E-57 Camera is located at camera site #4 and views entire launch
100 FPS vehicle, FSS, and MLP zero level.
1. Film underexposed and out of focus.
- E-59 Camera is located on SW side of pad perimeter near gate at camera
100 FPS site 4. Views vehicle as it passes through frame.
1. Film underexposed.
 2. Nothing visible.
- E-61 Camera is located on the SE pad perimeter just east of the gate
100 FPS on camera site 3 and views the launch vehicle, FSS, and MLP during ignition.
1. Film underexposed.
- E-65 Camera is located on camera site 2 at east pad perimeter and views
100 FPS ET L02 feedline, intertank, and RH SRB as vehicle passes through frame.
1. Was not committed for night operations.
- E-21 Camera is located inside the L02 TSM and views the disconnection
200 FPS of the T-0 umbilical.
1. T-0 disconnect appears normal.
- E-22 Camera is located inside the LH2 TSM and views the disconnection
200 FPS of the T-0 umbilical.
1. Film underexposed - no useful data.

- E-23 Camera is located on the MLP deck and views the +Y OMS engine
400 FPS nozzle.
1. Small pieces of tile and/or coating seen falling adjacent to RH OMS nozzle.
 2. RH OMS nozzle ripples.
 3. OMS engine butcher paper tears.
- E-24 Camera is located on the MLP deck and views the -Y OMS engine
400 FPS nozzle.
1. One shim falls adjacent to -Y OMS engine.
 2. OMS engine butcher paper tears.
 3. Poor film exposure.
- E-39 Camera is located on FSS and views latch-back assembly for
400 FPS GH₂ vent arm.
1. Film underexposed.
 2. Ice falls from GH₂ vent recovery line when line hits latch-back assembly.
- E-41 Camera is located on FSS and views the GH₂ vent arm assembly
400 FPS during retraction.
1. Large pieces of ice fall from GH₂ vent arm during SSME start-up and prior to T-0 (from approximately center 1/3 of arm).
 2. Arm drops and latches, lanyard swing toward vehicle.
 3. Several pieces of foreign material fall (largest piece approx 8"x4").
- E-42 Camera is located on 255 foot level and views LH SRB skirt as it
400 FPS passes ET GH₂ vent arm latch back area.
1. Approximately 10 pieces (1 ft² of ice fall from GH₂ vent arm at SSME start-up to T-0.
 2. H₂ vent arm was latched as vehicle rose from pad.
- E-43 Camera is located on pad surface and views beneath MLP to show
200 FPS sound suppression water system.
1. Not needed for STS-32.
- E-50 Camera is located at camera site 1 at NE pad perimeter. Overall
400 FPS view of GH₂ vent line including hinge and ET interface during disconnect and retract.
1. Distortion due to heat generated from H₂ burn pond.
 2. Ice falls from GH₂ vent arm at T-0.

- E-58 Camera is located at pad south perimeter and views the launch
100 FPS vehicle as it passes through the frame.
1. Film is underexposed.
 2. No anomalies observed.
- E-60 Camera is located on north pad perimeter at camera site 1 and
100 FPS views the entire launch vehicle, FSS, MLP and zero level.
1. Film unexposed.
 2. Ice falls from H₂ vent arm.
- E-62 Camera is located on the NE pad perimeter on camera site 1 and
100 FPS views the ET nose cone, upper FSS, and entire vehicle as it
 passes through the frame.
1. Did not run.
- E-63 Camera is located on NW side of pad perimeter and views entire
100 FPS launch vehicle, FSS and MLP from ignition through liftoff.
1. Film underexposed.
- E-216 Camera is located at UCS 16 east of 500 foot weather tower and
48 FPS views base of SRB exhaust plume from first acquisition to LOV.
1. No anomalies noted.

STS-32 (61-C)
SRB POST FLIGHT/RETRIEVAL DEBRIS ASSESSMENT
BIO24

The STS-32 SRB post-flight/retrieval inspection was conducted on January 14 and 15, 1985, at Hangar AF.

The SRB's splashed down 1.5 miles apart approximately 140 miles off Cape Canaveral, Florida. The RH and LH SRB impacted 9.5 and 9.0 miles, respectively, from the recovery ship "Independence". The RH frustum was floating 500 yards, and the LH frustum 60 feet, from their respective boosters. The sea state at retrieval was 5, with 7-12 foot swells and 20 knot winds decreasing to 5-9 foot seas by the end of the retrieval operation.

This was the tenth launch utilizing six large main parachutes. All paracutes appeared to have performed normally. The forward skirts were not equipped with cameras.

The forward skirts and frustums showed no signs of structural damage. The forward BSM aero heat shields were intact and locked in the open position except for two on the RH frustum. The outboard (toward +Z) shields, forward and aft, were open 90 and 60 degrees respectively due to bent attachment rings. The skirts and frustums continue to lose ablator material as follows:

	<u>DEBONDS</u>	<u>MISSING TPS</u>
LH FWD SKIRT	2	14
RH FWD SKIRT	9	15
LH FRUSTUM	6	5
RH FRUSTUM	11	6

The amount of TPS damage was average with the types of damage being typical of that seen on previous flights. The maximum divot size was 10"x12".

The RSS antennas had delaminations of the phenolic base plates at three locations. The exception was the RH SRB -Z location.

Both aft IEA covers had a minimal amount of nozzle debris damage. However, the RH IEA +Y end cover was missing K5NA closeout material. Evidence of heating indicates the K5NA was lost early in the flight.

The aft BSM's on the RH booster had missing/loose cork in large areas. Also aft BSM's on both boosters had cork missing from nozzles. All nozzle plug retainer rings were intact.

The stiffener rings had no visible damage due to water impact. Also the stiffener ring instafoam was essentially intact on all rings. The temperature sensors on the stiffener ring bolts were checked and the preliminary result is that the temperature did not exceed 60°C. One more flight will be made with the sensors to determine if the K5NA closeout of the stiffener ring bolts can be deleted.

The ETA rings and struts on both boosters had no observable damage. Instafoam remained intact through splashdown and had the usual nozzle debris impacts on the aft side of the ETA ring.

The SRB HDP foot pads showed shim material stayed intact to splashdown. All missing pieces had clean substrate exposed. HDP #1 had ordnance shrapnel in post opening.

The aft rings of the aft skirts had instafoam missing in moderate to large amounts. The RH aft ring had foam missing at HDP's 1 and 3 with about 120° total missing. Also foam was missing at the HPU exhaust ducts. The LH booster had about 4" wide of foam missing from the aft ring for nearly 360°. Sooting of the substrate indicates that much of the missing foam was lost early in the flight.

The aft skirts showed no structural damage. The RH skirt had 50% of interior foam remaining. The LH skirt had 80% of foam remaining but was quite sooted. There were no indications of HPU damage or fire in either skirt.

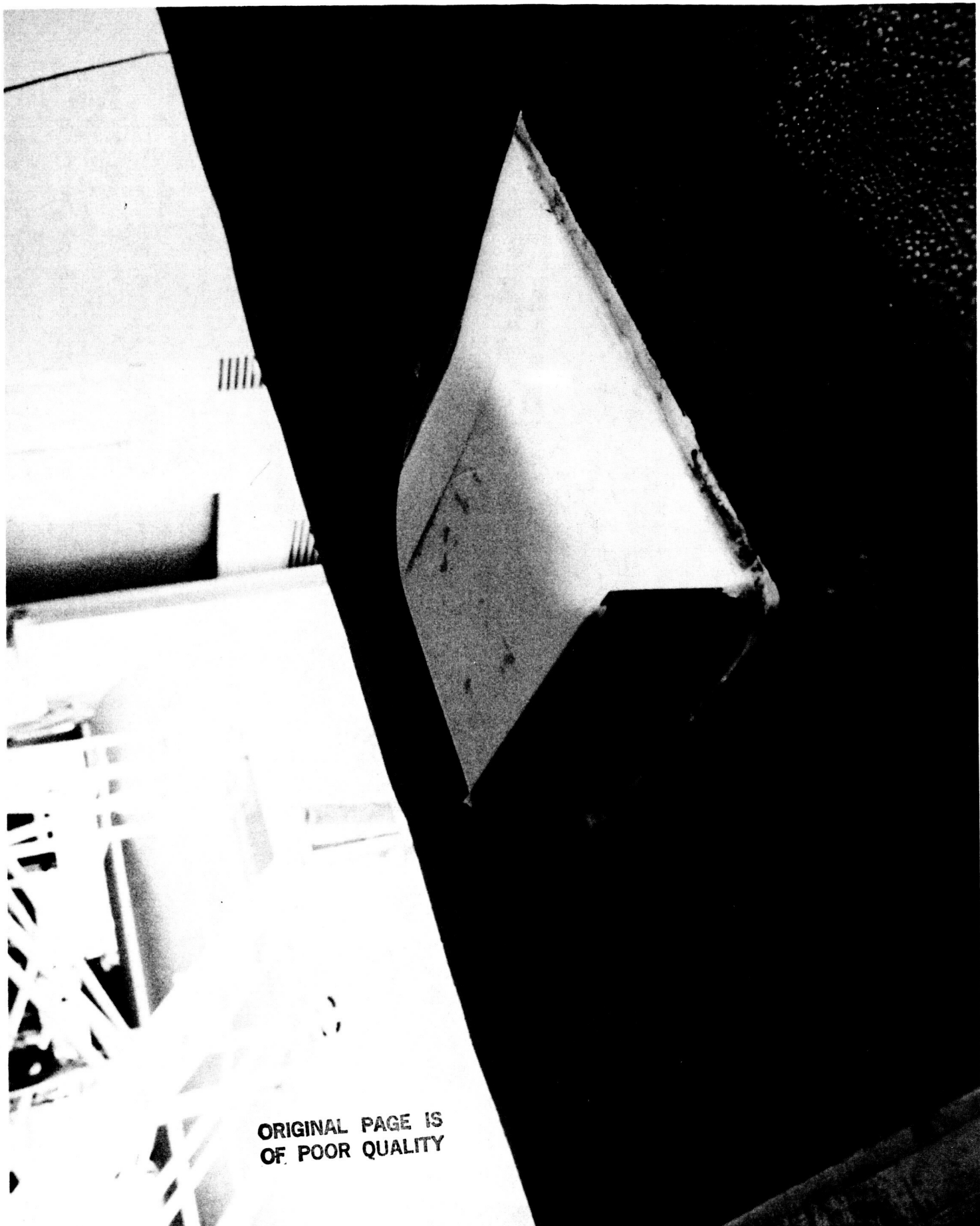
The LH booster was late in coming back due to problems installing the diver operated plug (DOP). The booster was towed in buoy mode until it reached the port. The DOP could not be removed at Hangar AF, possibly due to a separated nozzle inlet ring. Also two snubber plates were missing from the LH nozzle.

Other minor damage included some blistered paint on the LH fwd skirt forward of the thrust post and some scraped TPS on the systems tunnel on the RH SRB. The scraped TPS is possibly due to nozzle debris hits.

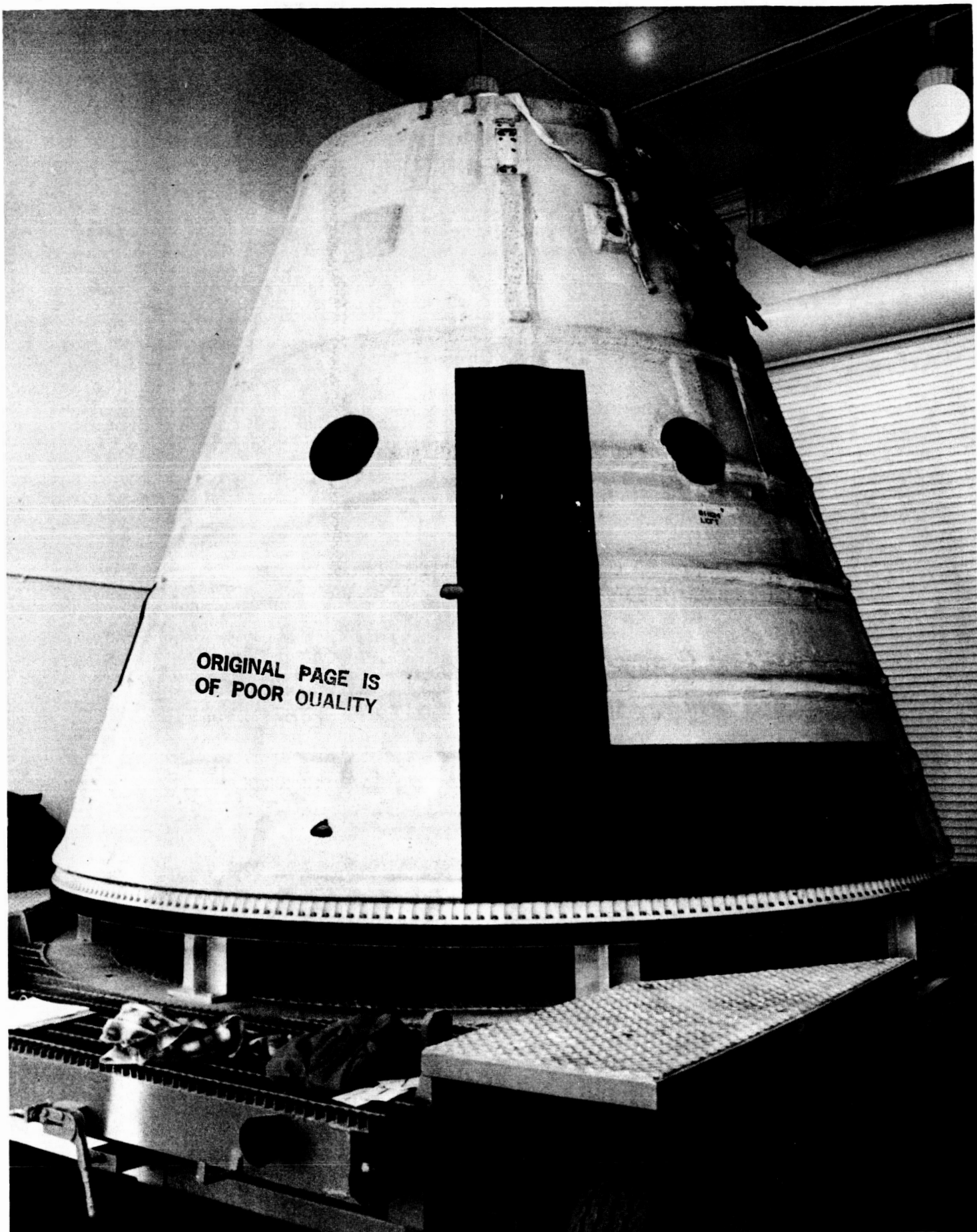
Generally, the overall condition of the boosters is very good. Probably the best seen to date. Loose ablator on the forward skirts and frustums continues to be a hazard to the Orbiter TPS. The large amounts of aft ring foam loss is also a concern for the Orbiter TPS.



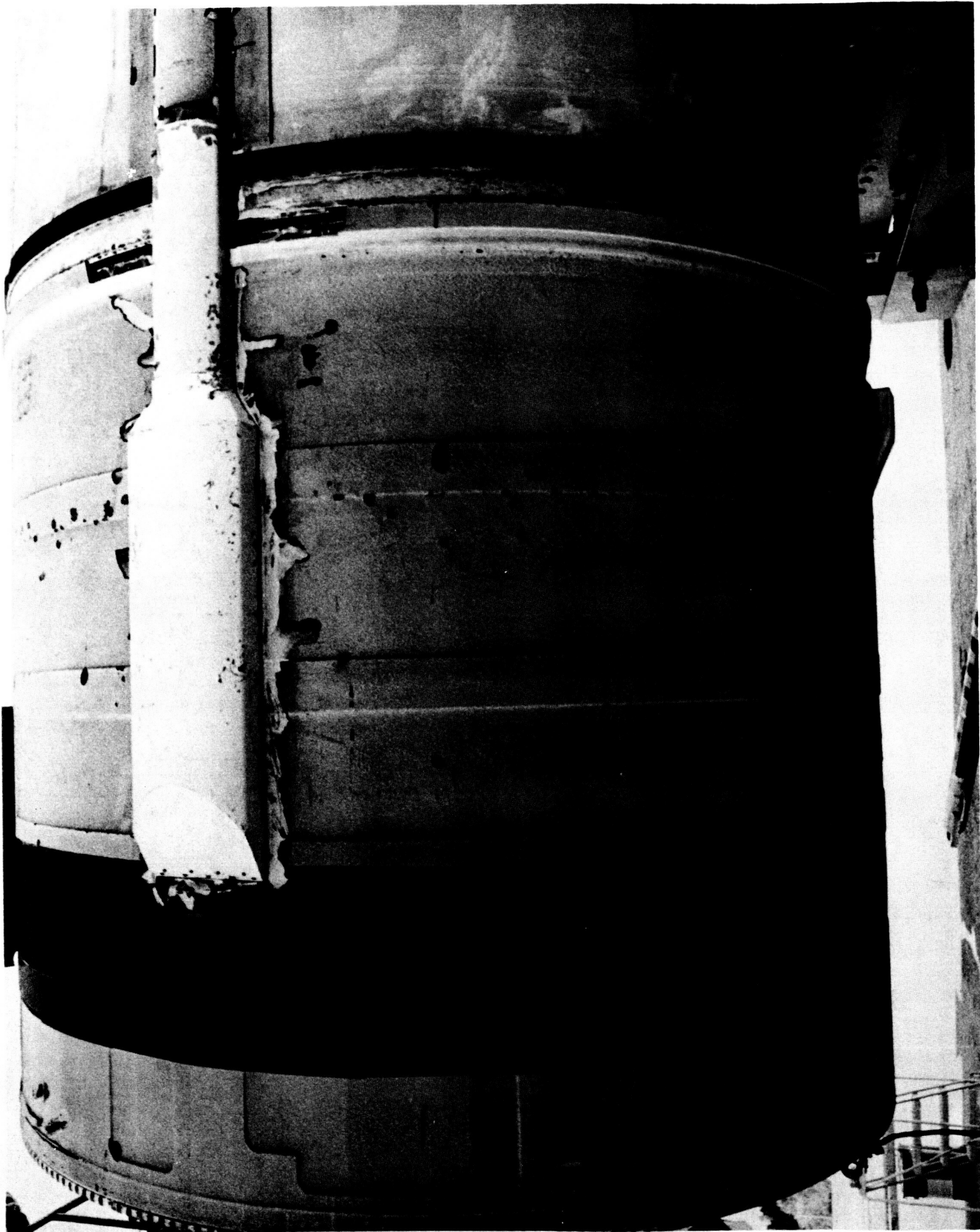
RH SRB Forward Skirt



RH SRB RSS antenna with phenolic baseplate



LH SRB Frustum



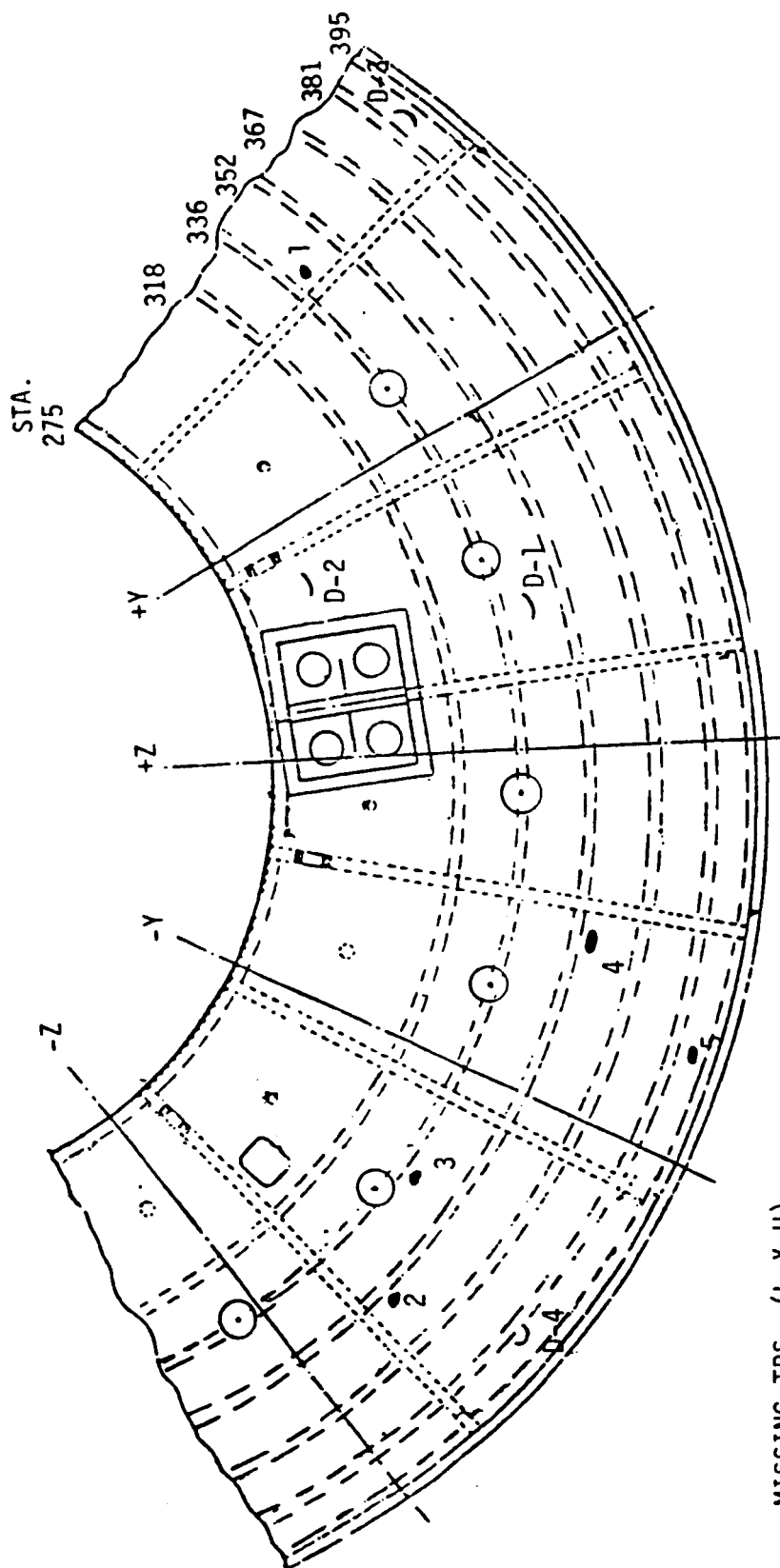
LH SRB Forward Skirt



LH SRB Aft Skirt foot/shim

ORIGINAL PAGE IS
OF POOR QUALITY

LEFT HAND FRUSTUM



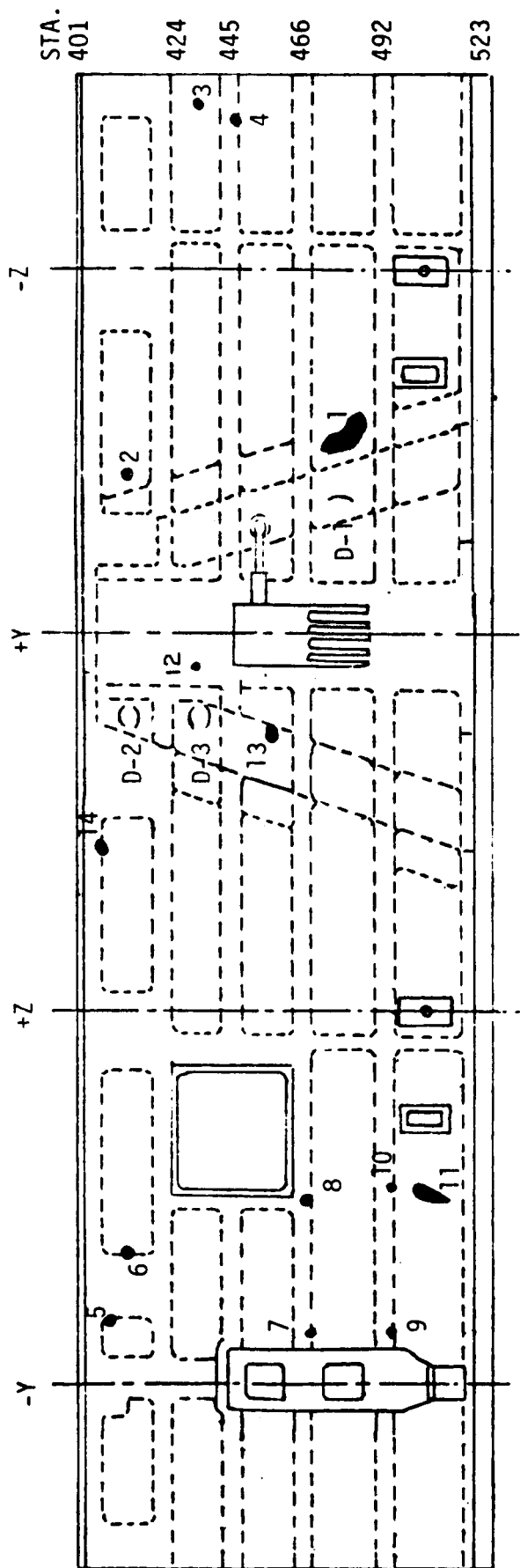
MISSING TPS (L X H)

1. 3 X 1½
2. 3 X 2
3. 3 X 2
4. 3 X 2
5. 2½ X 1½

DEBONDS

- D-1 ~ 2"
- D-2 ~ 2"
- D-3 ~ 3"
- D-4 ~ 2"

● APPROXIMATELY 1/2 CUP OF WATER IN SKIRT



MISSING TPS (L X H)

- | | |
|----------------|---------------|
| 1. 12 X 6 | 8. 1 X 2 |
| 2. 1" dia. | 9. 2 X 2 (S) |
| 3. 1" dia. | 10. 1 X 1 (S) |
| 4. 2 X 6 (S) | 11. 3 X 9 (S) |
| 5. 2 X 2 | 12. 1 X 1 |
| 6. 3 X 2 (S) | 13. 4 X 2 |
| 7. 1½ X 2½ (S) | 14. 2 X 2 |

s - DENOTES A SCRAPE

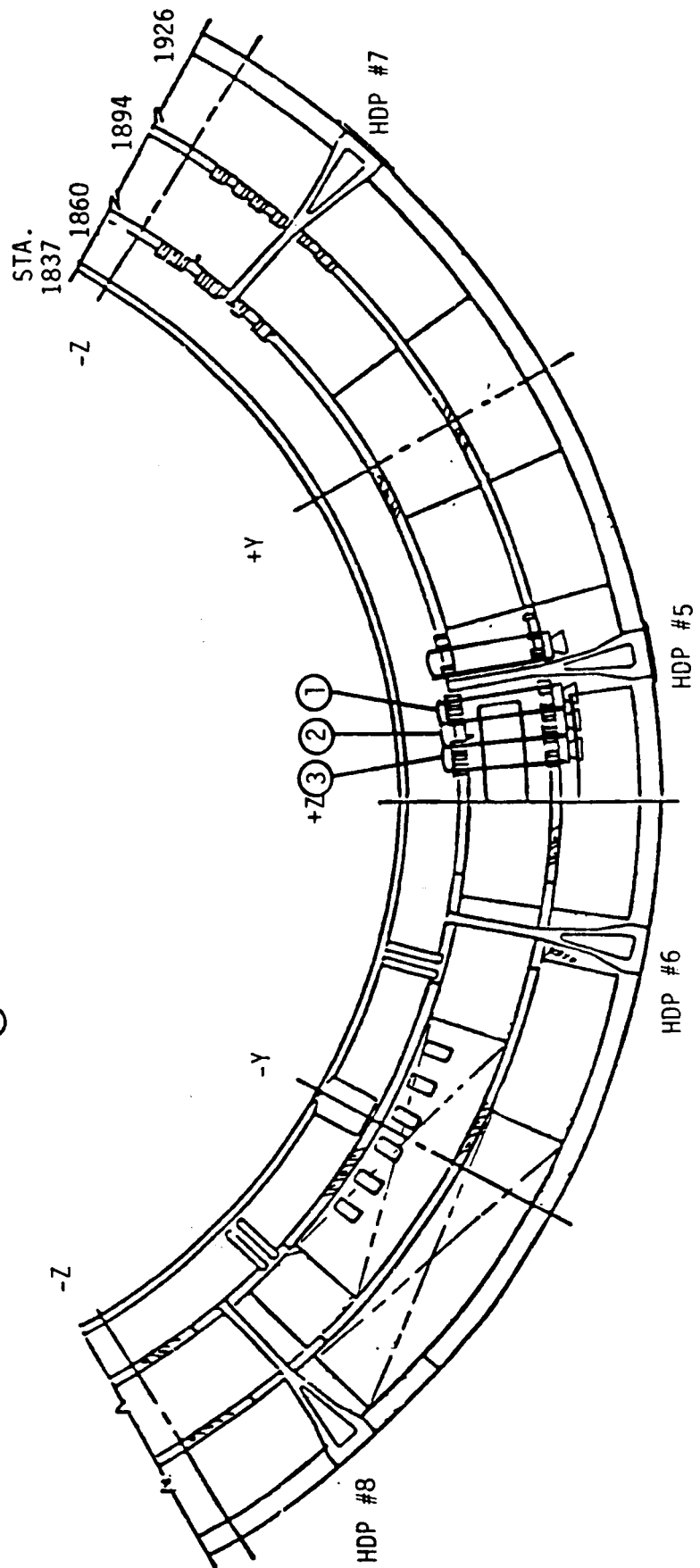
DEBONDS

- | | |
|-----|---------|
| D-1 |) 3" |
| D-2 | (3 X 2 |
| D-3 | (2 X 3 |

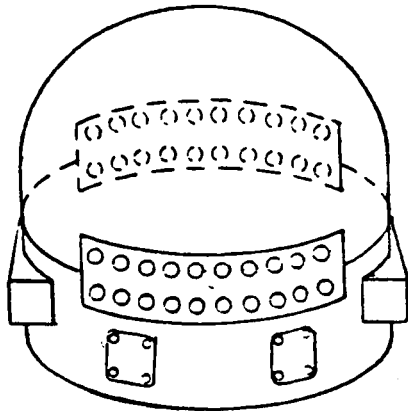
LEFT HAND FORWARD SKIRT

LEFT HAND AFT SKIRT EXTERIOR TPS

- SINGLE BSM - OUTBOARD CORK DEBONDED BUT INTACT
INBOARD CORK DEBONDED BUT INTACT
- TRIPLE BSM - ① OUTBOARD & INBOARD CORK DEBONDED BUT INTACT
② OUTBOARD & INBOARD CORK DEBONDED BUT INTACT
③ OUTBOARD & INBOARD CORK DEBONDED BUT INTACT



REMARKS

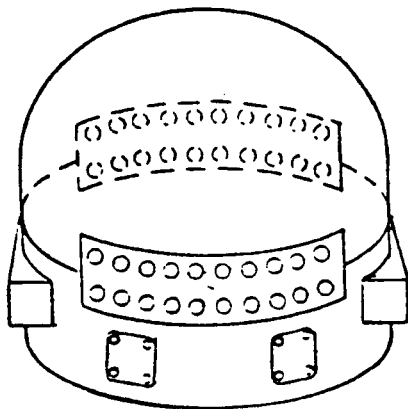


HDP # 5

S/N 002

NO PUNCTURES

NO BOLTS OUT

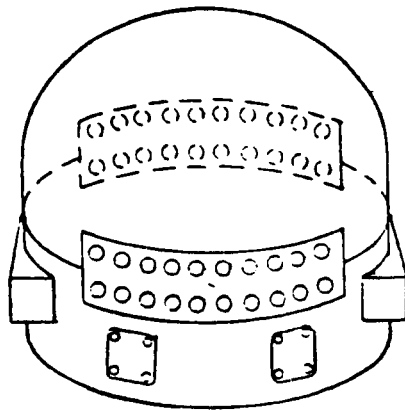


HDP # 6

S/N 1000155

NO PUNCTURES

NO BOLTS OUT

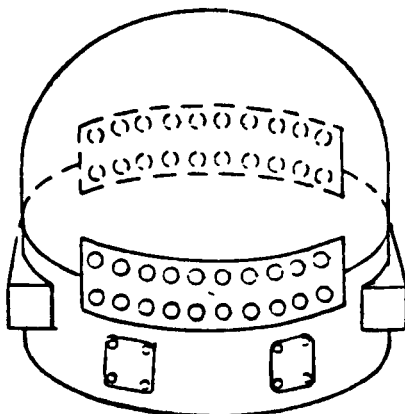


HDP # 7

S/N 1000156

NO PUNCTURES

NO BOLTS OUT



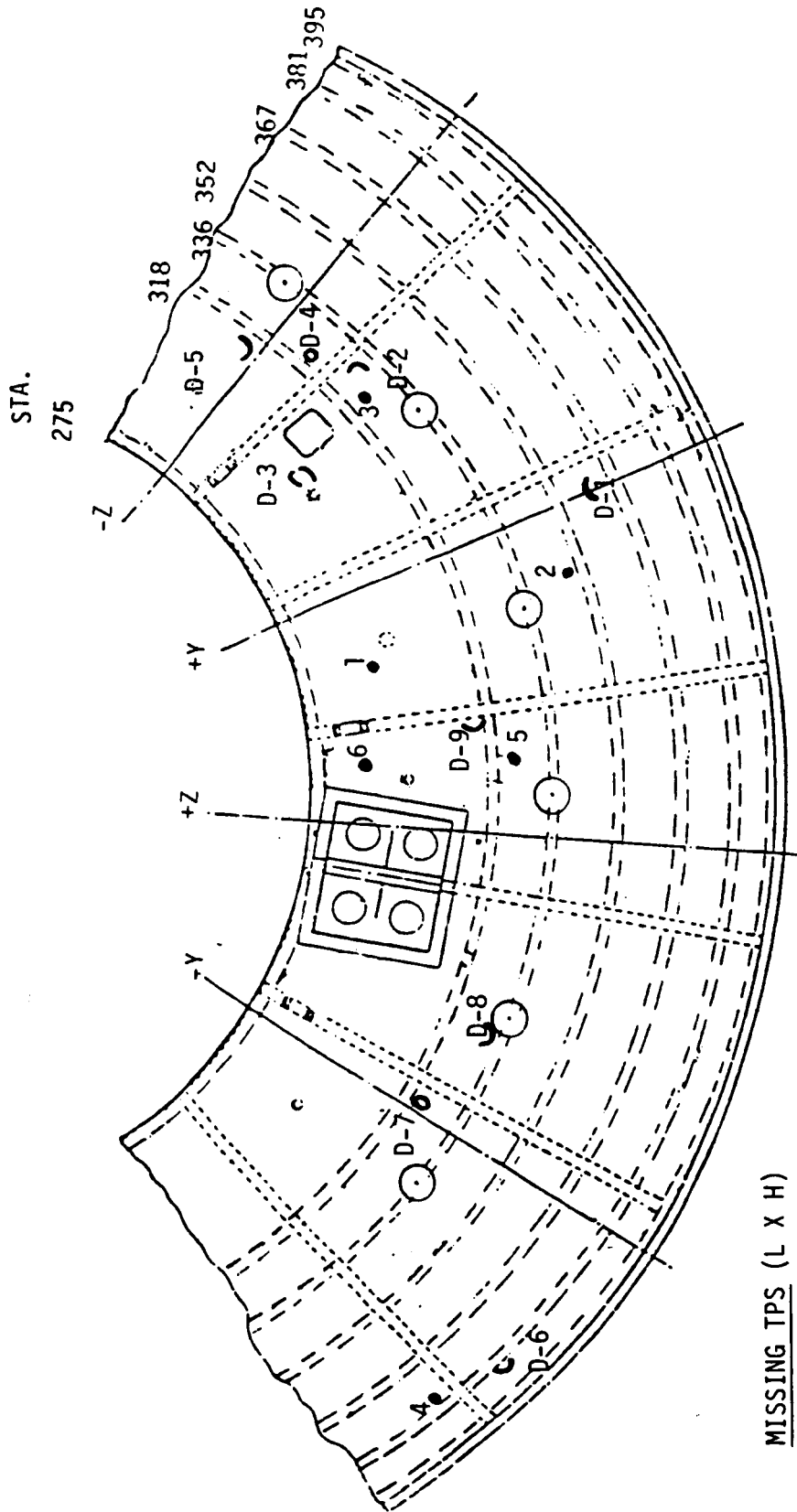
HDP # 8

S/N 1000151

NO PUNCTURES

NO BOLTS OUT

RIGHT HAND FRUSTUM



MISSING TPS (L X H)

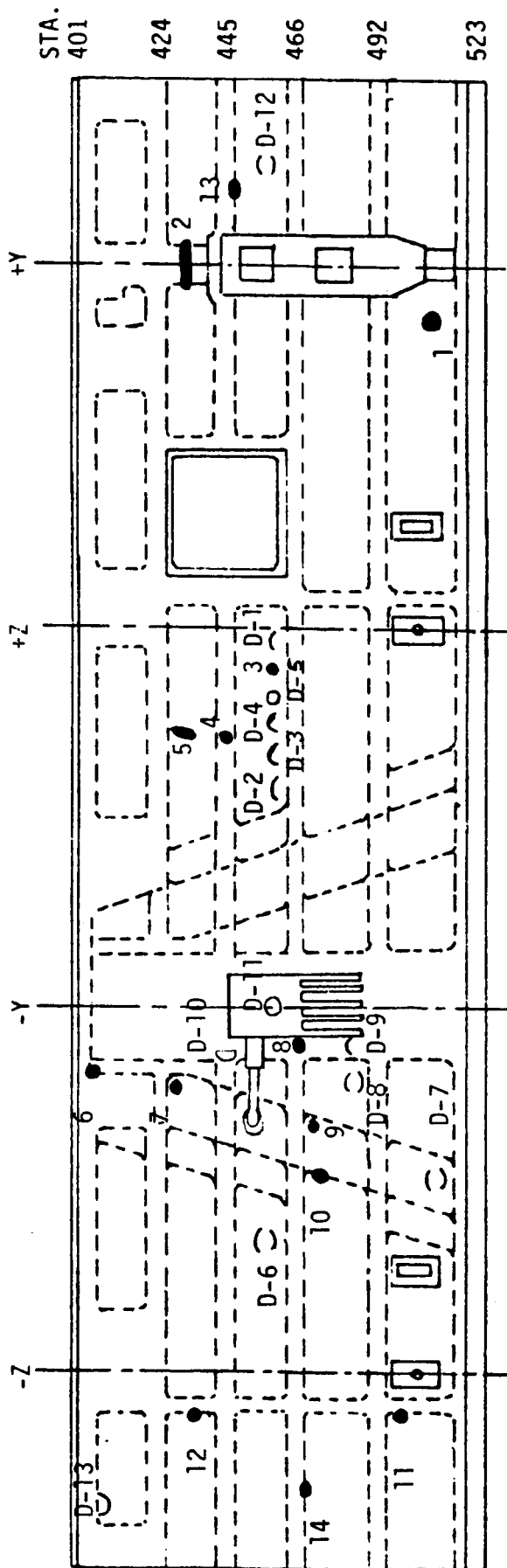
1. 1" dia. *
2. 1 X 1/2 not to substrate
3. 1" dia. *
4. 2 X 2
5. 1" dia. *
6. 2 X 1

* PR1422 Sealant found on surface

DEBONDS

- D-1 ~ 2"
- D-2 ~ 1"
- D-3 ~ 4 X 2
- D-4 ~ 1" dia.
- D-5 ~ 1 1/2"
- D-6 ~ 2 1/2"
- D-7 ~ 1" dia.
- D-8 ~ 1"
- D-9 (1 1/2"

- APPROXIMATELY 1/2 CUP OF WATER IN CENTER OF SKIRT AND 1/2 CUP IN AREA NEXT TO AFT SEAL.
- ONE ORDNANCE RING PIN MISSING - APPROXIMATELY 5 PINS BACKED OUT SOME.



MISSING TPS (L & H)

1. 2" dia.
2. 12 X 2
3. 1" dia.
4. 2 1/2" X 1
5. 1 1/2 X 6 (S)
6. 1/2 X 1 (S)
7. 1 X 1
8. 3 X 1
9. 4 X 2
10. 3 X 2
11. 4 X 2
12. 3 X 2
13. 1" dia. (S)
14. 1 1/2" dia.

S - DENOTES SCRAPE

DEBONDS (L & H)

- D-1 ~ 1"
- D-2 ~ 1"
- D-3 ~ 1"
- D-4 ~ 1"
- D-5 ~ 1" dia.
- D-6 ~ 1" X 2"
- D-7 ~ 4 1/2 X 3
- D-8 ~ 2 X 2
- D-9 ~ 3"

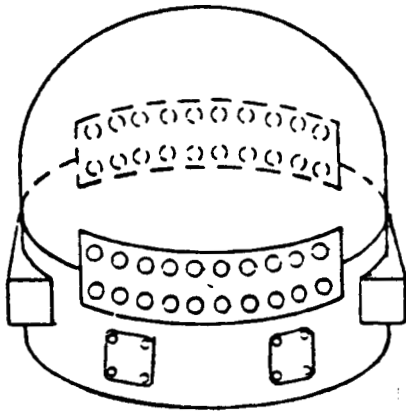
- D-10 1 X 2
- D-11 3 1/2" dia. (cork)
- D-12 3 X 2
- D-13 2 X 1

RIGHT HAND FORWARD SKIRT

- SINGLE BSM - OUTBOARD CORK MISSING - INBOARD CORK DEBONDED BUT INTACT
- TRIPLE BSM -
 - ① OUTBOARD CORK MISSING - INBOARD CORK DEBONDED BUT INTACT
 - ② OUTBOARD CORK DEBONDED BUT INTACT
 - ③ OUTBOARD CORK & INBOARD CORK DEBONDED BUT INTACT



REMARKS

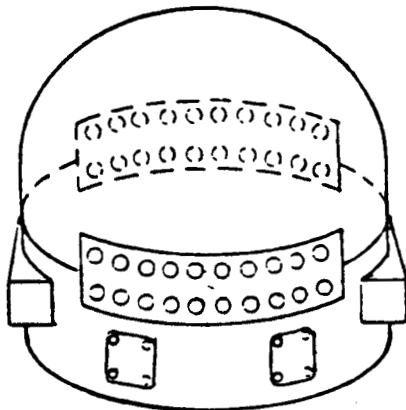


HDP # 1

NO PUNCTURES

NO BOLTS OUT

S/N 1000188

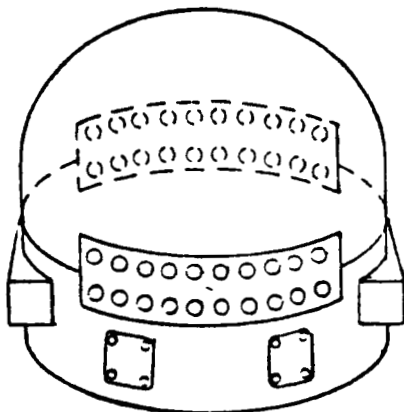


HDP # 2

NO PUNCTURES

NO BOLTS OUT

S/N 1000157

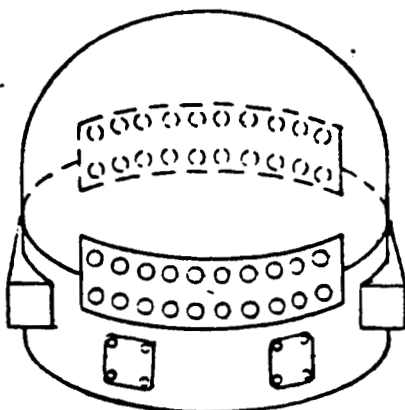


HDP # 3

NO PUNCTURES

NO BOLTS OUT

S/N 1000166



HDP # 4

NO PUNCTURES

NO BOLTS OUT

S/N 1000001

STS-32 (61-C)
RH SRB DEBRIS ASSESSMENT
PHOTO REFERENCE

<u>SUBJECT</u>	<u>PHOTO CONTROL NUMBER</u>
FORWARD SKIRT	Roll 1: #2,3,18,19,20,23
IEA	#4 5,12
BSM	#6,15,16,17
AFT SKIRT SHIMS	#7,9,10
NOZZLES	#8
STIFFENER RINGS	#13,14
RSS ANTENNA	#21
FORWARD CROSSOVER	#22

STS-32 (61-C)
LH SRB DEBRIS ASSESSMENT
PHOTO REFERENCE

<u>SUBJECT</u>	<u>PHOTO CONTROL NUMBER</u>
RSS ANTENNA	Roll 1: #2,18
FORWARD SKIRT	#3,5,16
FORWARD CROSSOVER	#4
NOZZLE	#6,12
AFT SHIRT SHIMS	#7,8,11
IEA	#9
BSM	#10
STIFFENER RINGS	#14,15
SYSTEMS TUNNEL	#17
FRUSTUM, RH AND LH	#19-26

STS-32 (61-C)
POST-LANDING DEBRIS DAMAGE ASSESSMENT
OV-102, ET-30, BIO24 and MLP-1
JANUARY 18-19, 1986

A detailed Post-Landing Inspection of OV-102 was performed by the Debris Assessment Team on January 18 and 19, 1986 for the purpose of identifying debris impacts, damage caused, and possible debris sources. The inspection was conducted at Dryden (EAFB) on Concrete Runway 22 and the Mate/Demate Device (MDD). The Western Contingency Debris Assessment Team were deployed with the mini-convoy and conducted the preliminary runway assessment. The MDD assessment was conducted by the full-up team - the remaining members having arrived via C-5A on Saturday. The Orbiter sustained a total of 193 debris-related impacts of which 39 had a major dimension of one inch or greater. By comparison, the debris impacts for STS-31 (61-B) were 257 and 55, respectively. These numbers do not include the numerous small hits typically observed on the base heat shield and upper body flap (approximately 100).

No post-landing walkdown on Runway 22 was performed as vehicle touchdown occurred during pre-dawn hours (0559 PDT) and the mini-convoy did not provide this flexibility. The runway was cleaned prior to landing. Based on the Team's assessment, no Orbiter parts are believed to have been lost during rollout. The Orbiter touched down 1525 feet from the threshold and rolled a total distance of 10,200 feet. NLG steering was not utilized. The majority of the TPS damage occurred on the lower Orbiter surface which sustained a total of 134 impacts of which 20 had at least one dimension greater than one inch. While 50 impacts occurred on the lower surface forward of the MLG doors, most of these were minor in nature with only three impacts have a dimension greater than one inch. If this area is increased to also include the nose and upper surfaces, the impacts would only increase to a total of 69, three greater than one inch. The remainder of the 124 impacts aft of the vehicle MLG door surfaces is typical of earlier flights when no major pieces of ET foam were lost. Most of the larger lower surface damaged areas occurred on the left hand wing and elevons. The nine major outboard impacts exactly matches the number of ice impacts observed on high speed launch film. During the film review, large pieces of ice were observed to fall from the ET GH2 facility vent arm. Ten impacts were observed - nine hitting the lower tiled surfaces and the largest piece (18x10 inches) hitting the wing RCC panel. No damage to the RCC panel has been observed.

The typical cluster of small hits around the ET/ORB umbilicals occurred again during this flight. Of the 27 hits in this area, only 3 had a dimension of one inch or greater.

A larger than normal number of missing gap fillers were observed. Several gap fillers were protruding.

A total of 19 diced tile and white tile segments were missing from the left and right hand fuselage sidewalls, nose upper surface and wing and elevon upper surfaces. The tile missing from the bottom of the star tracker well is believed to be that piece which was station keeping with the vehicle on-orbit and reported by the crew. One of the missing pieces was found by the Debris Team during the post launch pad inspection.

Both OMS pods sustained several debris impacts. The right OMS pod sustained a major impact resulting in a damaged area 6 x 3 x 3/4 inch over three tiles. Tiles must be removed in this area to facilitate structural delamination testing. Several protruding, loose and missing gap fillers were observed. Missing tiles from the fuselage sidewalls probably contributed to the OMS pod and left hand rudder tile damage.

A 12-inch long piece of metal seal material is loose and falling off from the inside surface of the left hand speed brake. This is the largest single damaged piece observed in this area to date.

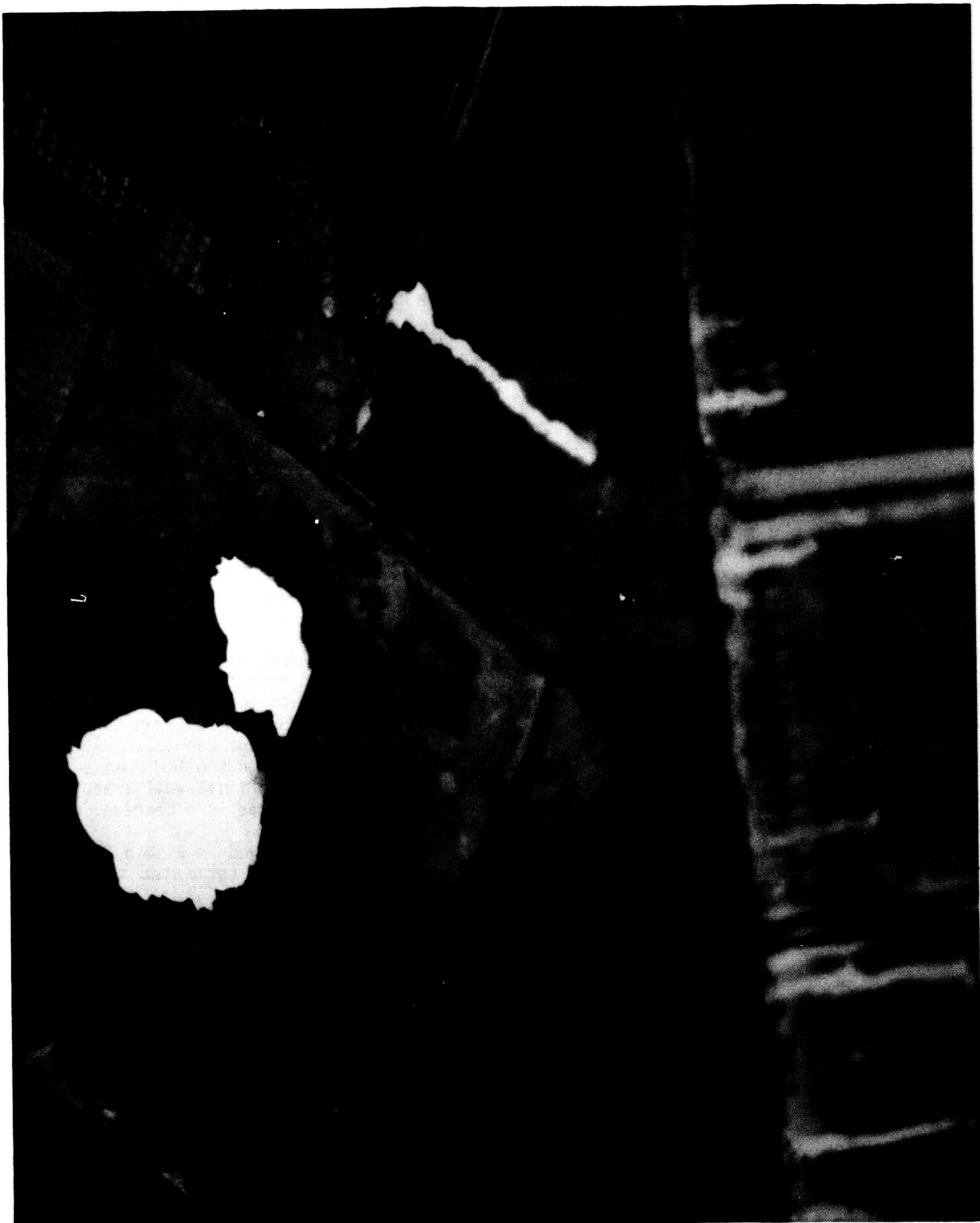
The typical white streaks frequently observed on the windshields were not present. Very minor, if any, haze was visible on the Fwd windows. Considerable contamination of the windows occurred while sitting in the MDD. A one-inch diameter brown spot was found on the upper left hand corner thermal pane of window #4. This will be evaluated upon return to KSC. Two tile craters (3/4 x 3/4 x 1/2 inch) located just above and aft of window #6 also needs further evaluation.

The thermal blanket material around all three SSME's was badly frayed, loose, or missing. This material will probably have to be replaced.

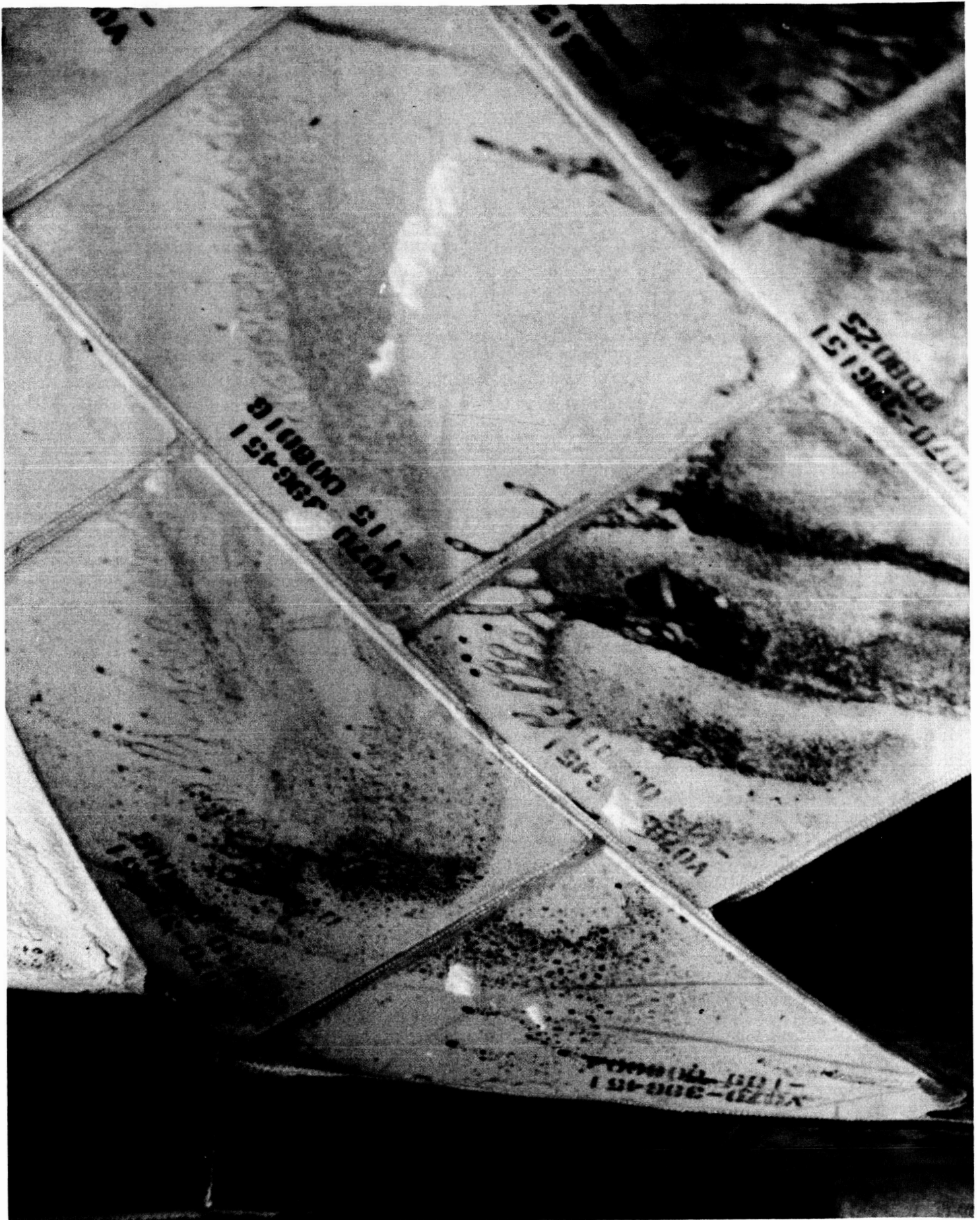
The tires, wheels, and brakes were in good condition. The brakes were removed intact while sitting on the runway. A few loose metal chips were found in the right hand outboard brake.

An inspection of the L02 ET/Orb umbilical well revealed a sedimentary deposit of coarse black powdery material is believed to be ET umbilical foam fire retardant coating. A 1x6 inch piece of the coating was also found. A piece of material (NSI assembly 3-1/2 x 1 inches) from the ET/Orb separation bolt was found loose up in the lower hinge mechanism. At separation, the nut prevented the plunger from falling into the bolt hole leaving an area for broken pieces to exit into the umbilical well area. Debris in the area of the hinge mechanism and tile moldline is a concern.

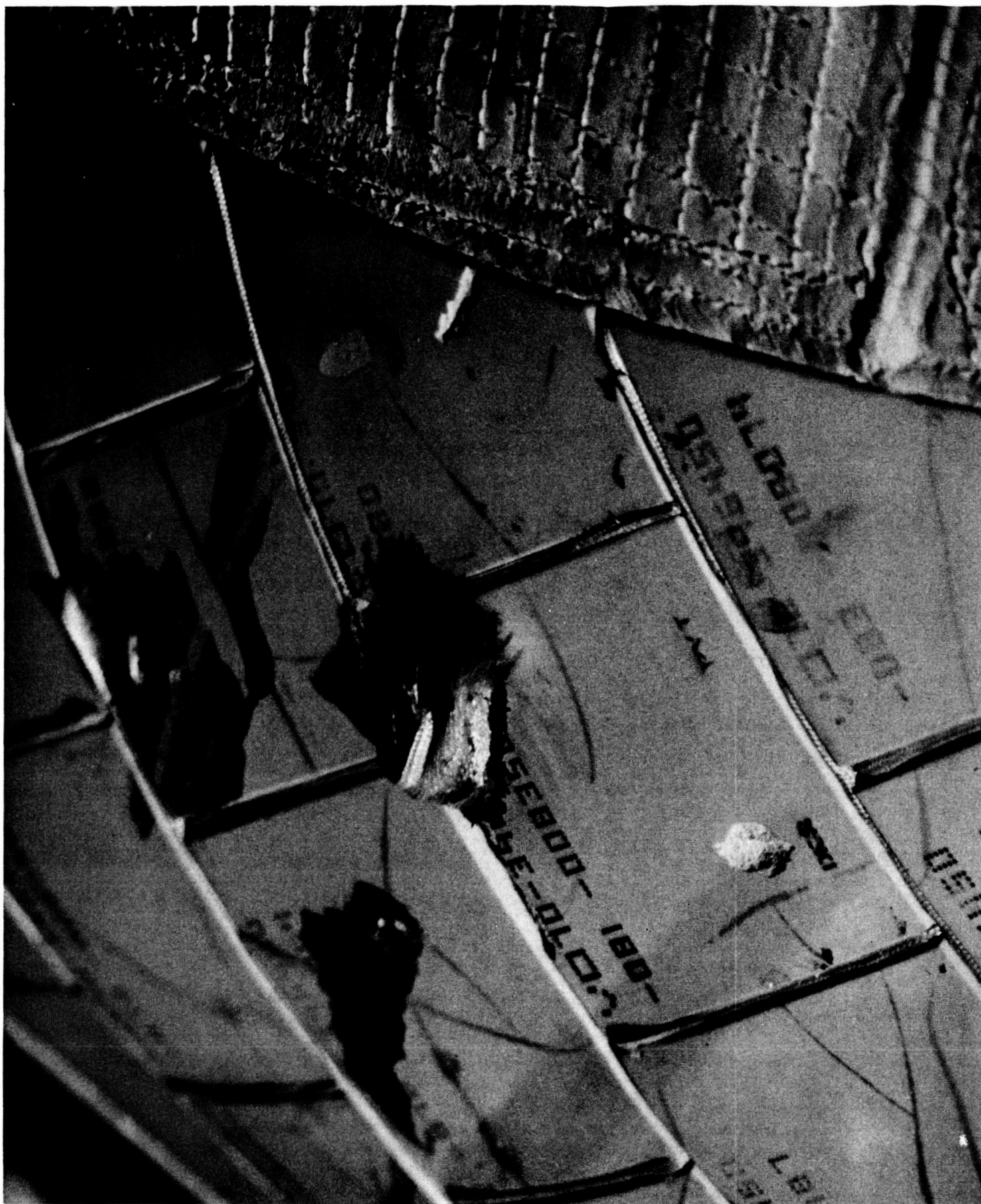
In summary, the amount of lower surface damage observed is within the average sustained for previous operational flights. It is estimated that 10 to 12 tiles will have to be scrapped.



Typical tile damage

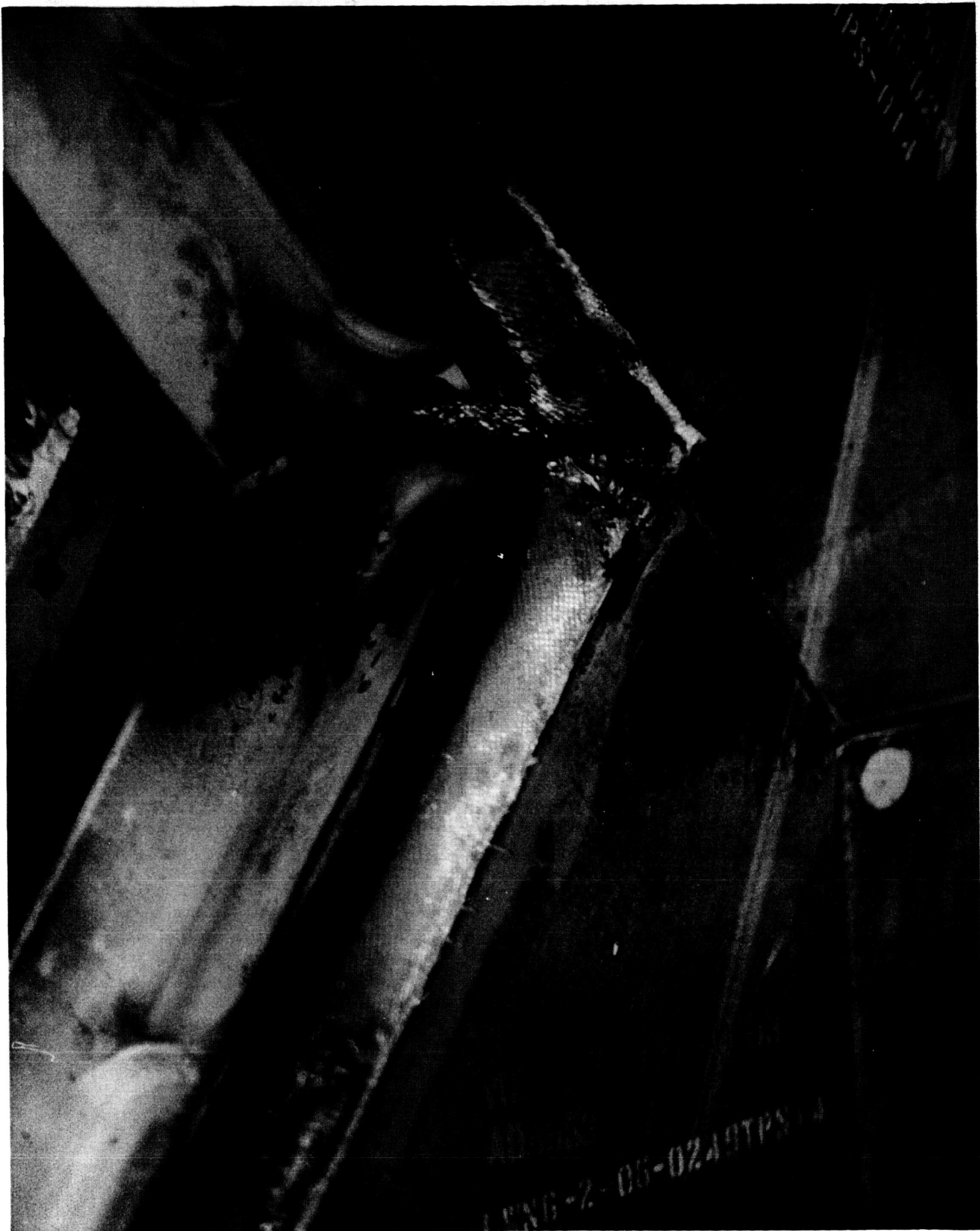


Typical OMS Pod tile damage

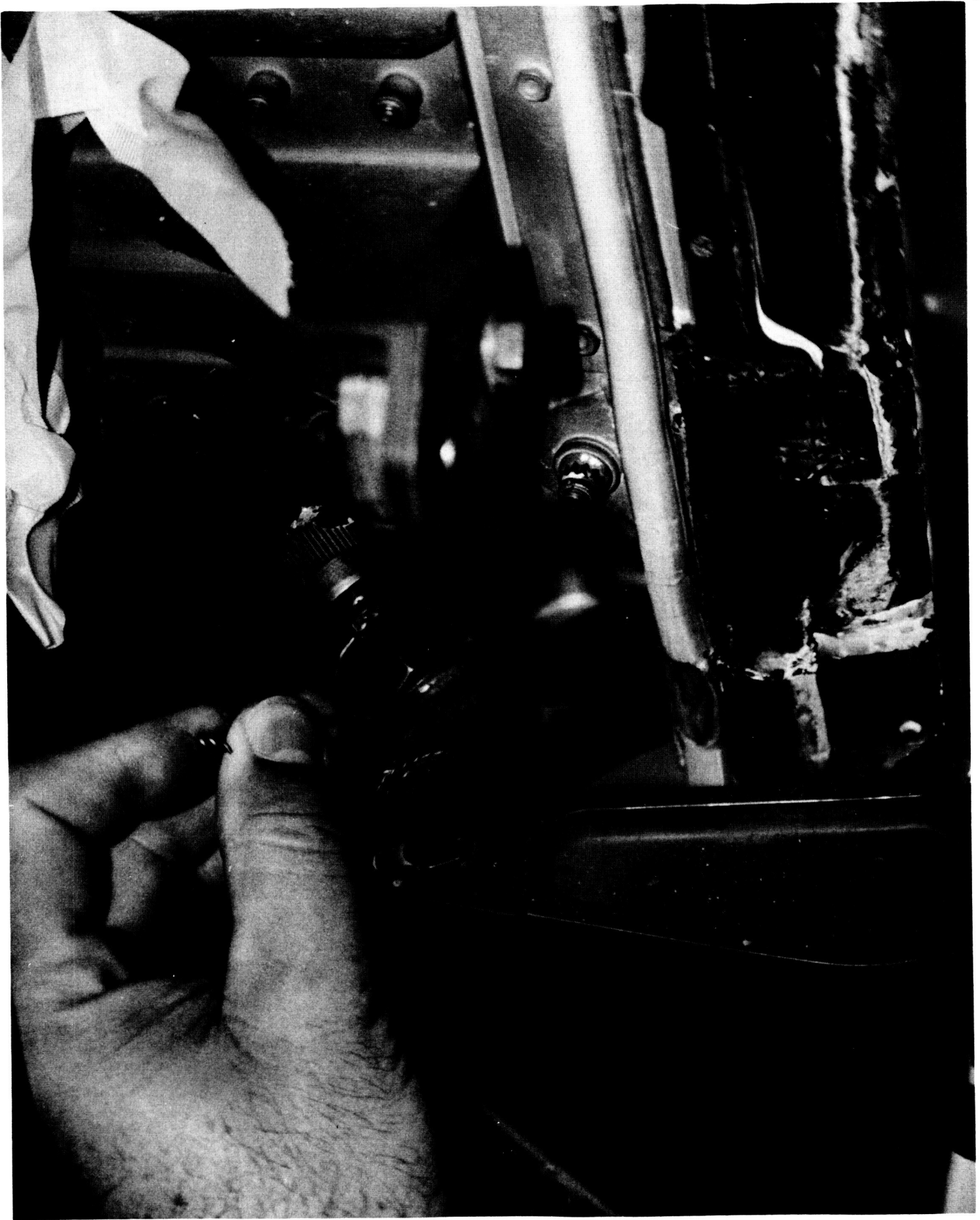


OMS Pod protruding gap filler

ORIGINAL PAGE IS
OF POOR QUALITY



LO2 ET/ORB Umbilical well heat intrusion ORIGINAL PAGE IS
OF POOR QUALITY



Loose NSI asseblly from ET/ORB Separation Bolt

**ORIGINAL PAGE IS
OF POOR QUALITY**



ORIGINAL PAGE IS
OF POOR QUALITY

NSI fragments in Separation Bolt hole

ORIGINAL PAGE IS
OF POOR QUALITY

STS-32 (61-C)
DEBRIS DAMAGE ASSESSMENT
SUMMARY

	Hits \geq 1 Inch	TOTAL HITS
Lower Surface	20	134
Top Surface	4	10
Right Side	2	11
Left Side	7	15
Right OMS Pod	3	14
Left OMS Pod	3	9
TOTALS	39	193

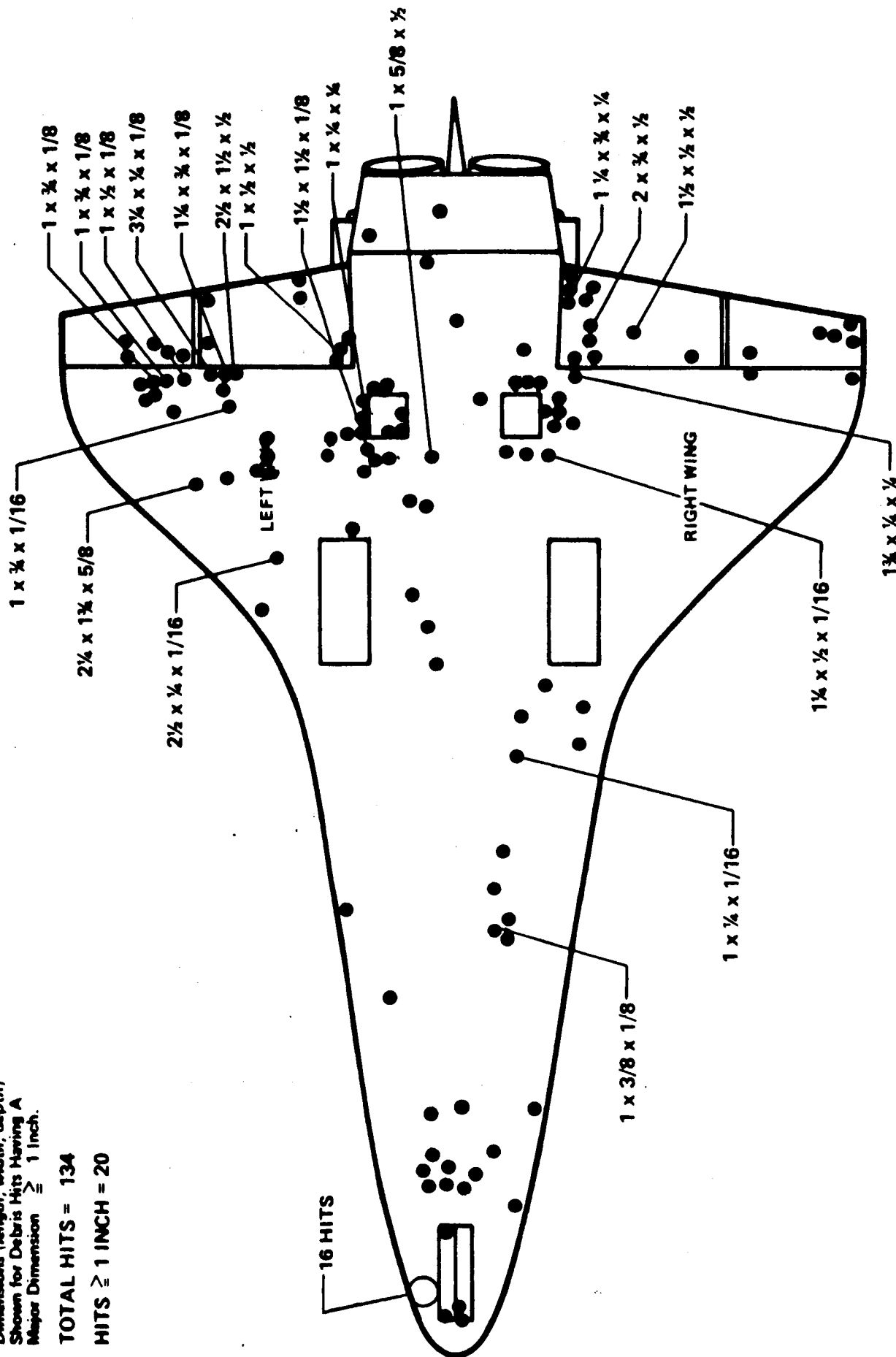
COMPARISON TABLE

	Hits \geq 1 Inch	TOTAL HITS
STS-6	36	120
STS-7	48	253
STS-8	7	56
STS-9 (41-A)	14	58
STS-11 (41-B)	34	63
STS-13 (41-C)	8	36
STS-14 (41-D)	30	111
STS-17 (41-G)	36	154
STS-19 (51-A)	20	87
STS-20 (51-C)	28	81
STS-23 (51-D)	46	152
STS-24 (51-B)	63	140
STS-25 (51-G)	144	315
STS-26 (51-F)	226	553
STS-27 (51-I)	33	141
STS-28 (51-J)	17	111
STS-30 (61-A)	34	183
STS-31 (61-B)	55	257
STS-32 (61-C)	39	193

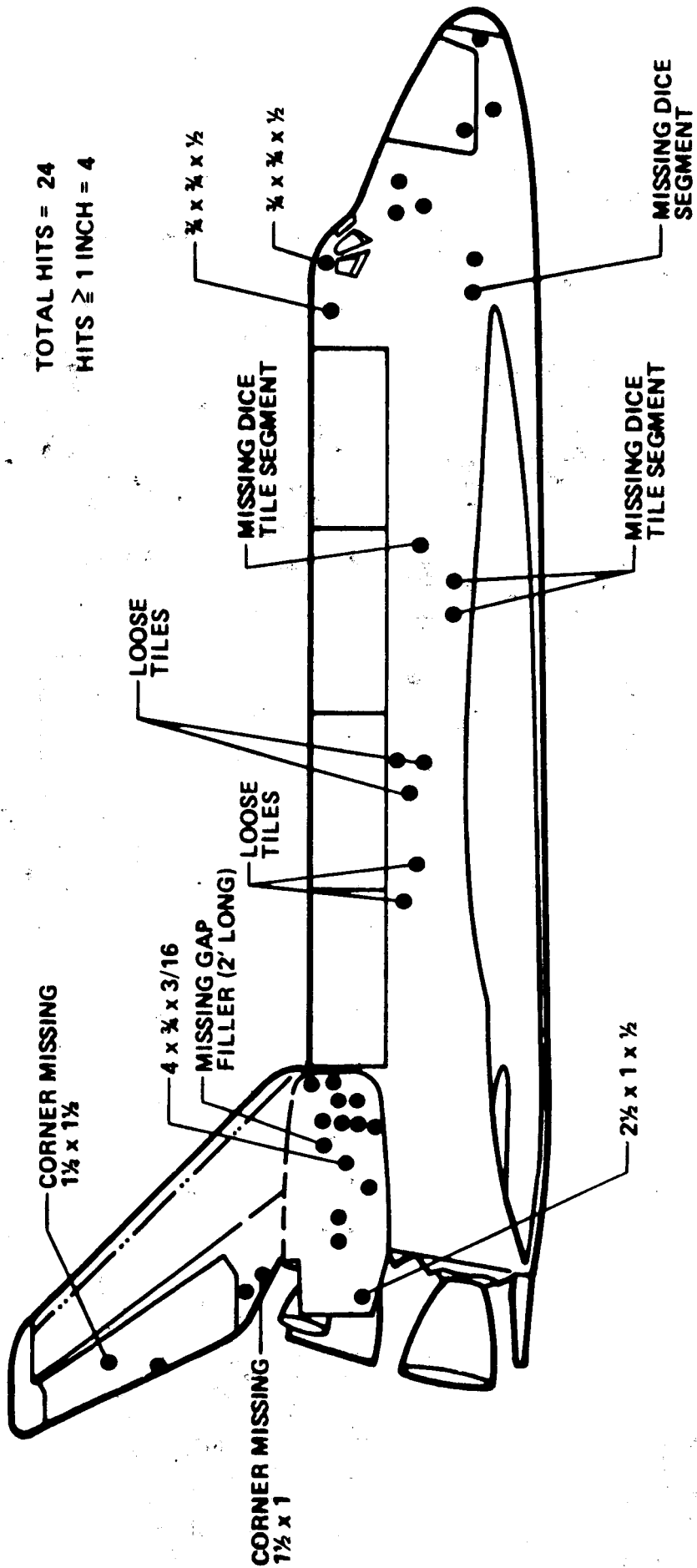
NOTE:
Dimensions (length, width, depth)
Shown for Debris Hits Having A
Major Dimension ≥ 1 inch.

TOTAL HITS = 134

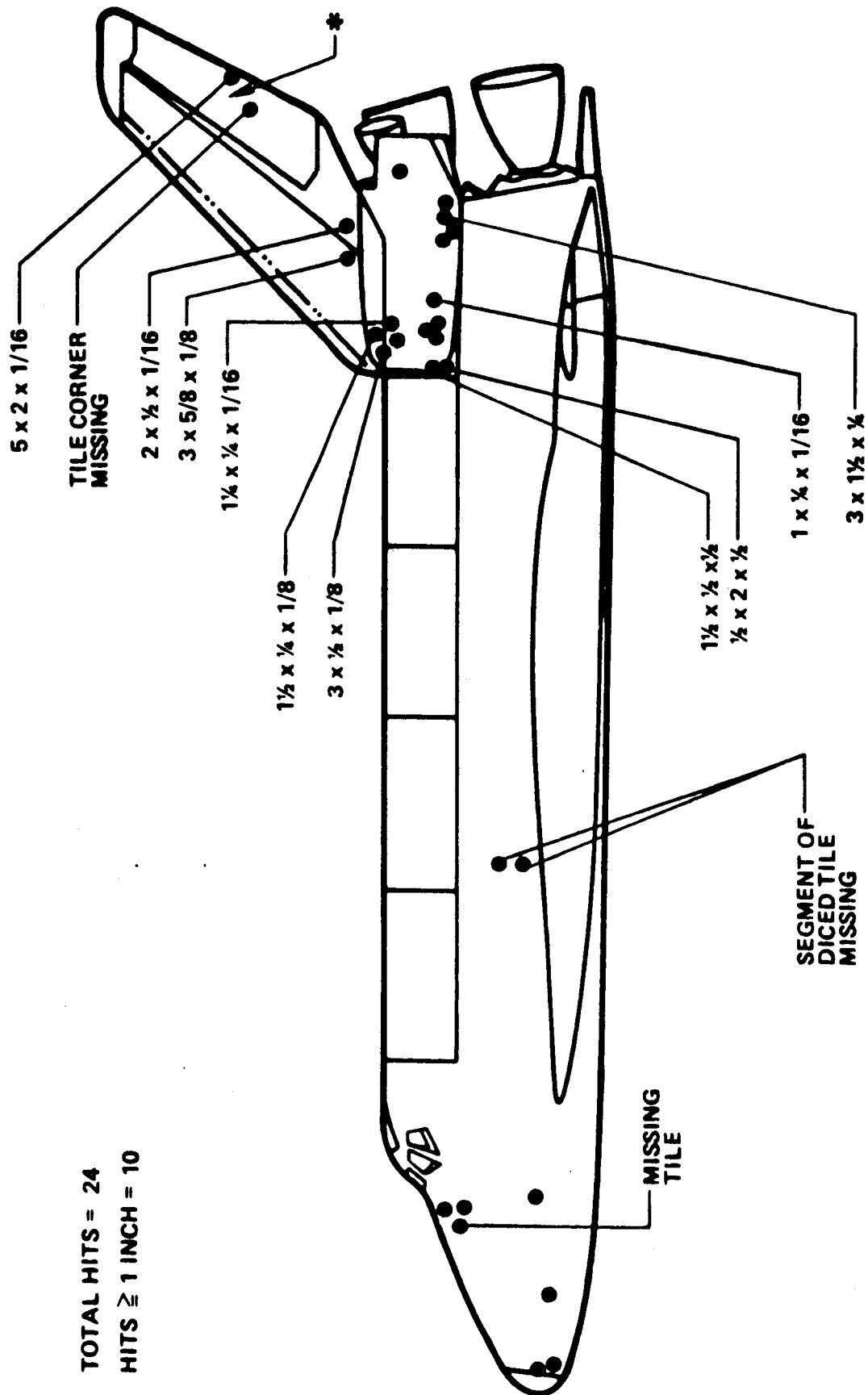
HITS ≥ 1 INCH = 20



MISSION - STS 32 (61C)
 DEBRIS DAMAGE MAP
 RIGHT SIDE



MISSION - STS 32 (61C)
DEBRIS DAMAGE MAP
LEFT SIDE



TOTAL HITS = 24
HITS \geq 1 INCH = 10

*12" LONG METAL SEAL LOOSE AND FALLING OUT
LOCATED ON INSIDE SURFACE OF LEFT SPEED BRAKE

MISSION — STS 32 (61C)

DEBRIS DAMAGE LOCATIONS

UPPER SURFACE

CORNER
MISSING
 $\frac{1}{2} \times \frac{1}{2}$

* $1\frac{1}{2} \times 1$ & $\frac{1}{2} \times \frac{1}{2}$
PIECES MISSING

1 x 1 INCH PIECE
MISSING

1 x 1 INCH CORNER
MISSING

6 x 3 x $\frac{1}{2}$
(THREE TILES)

3 x 3 x 1
GOUGE

1 x $\frac{1}{2}$ x $\frac{1}{2}$
GOUGE

GOUGE, LOOKS LIKE
BUCKET BASE

1 $\frac{1}{2}$ x $\frac{1}{2}$ x $\frac{1}{2}$
GOUGE

TILE SEGMENT
MISSING

6 x 3 AREA
BADLY ERODED
(FILLER BAR
VISIBLE)

TILE SEGMENT
MISSING

TILE SEGMENT
MISSING

6 x 1 $\frac{1}{2}$ SEGMENT
OF TILE DAMAGED
& LOOSE

TOTAL HITS = 11

HITS ≥ 1 INCH = 5

$\frac{1}{2} \times \frac{1}{2}$ CORNER
OF TILE LOOSE

* PIECE FOUND ON PAD

STS-32 (61-C)
OV-102 POST LANDING DEBRIS ASSESSMENT
PHOTO REFERENCE

<u>SUBJECT</u>	<u>PHOTO CONTROL NUMBER</u>
UMBILICALS	Roll 1: #31-37 Roll 2: #21,24
WINDOWS	Roll 1: #0-3 Roll 2: #6
STAR TRACKER DOORS	Roll 1: #4 Roll 2: #19
TILES	Roll 1: #5,12,15-23,25,30 Roll 2: #1-5,8,10,13-18,20,22,23 27-33,35,36
SSME	Roll 1: #6,26,27,29 Roll 2: #
WHEELS	Roll 1: #7-11, 13,14
AFRSI PANELS	Roll 1: #24
SPEED BRAKE	Roll 1: #28
GAP FILLER	Roll 2: #6,7
OMS NOZZLE	Roll 2: #12
NOSECONE	Roll 2: #34

STANDARD TITLE PAGE

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15. Abstract An Ice/Frost/Debris assessment was conducted for Space Shuttle Mission STS-32 (61-C). This assessment begins with debris inspections of the flight elements and launch facilities before and after launch. Ice/Frost formations are calculated during cryogenic loading of the External Tank followed by an on-pad assessment of the Shuttle vehicle and pad at T-3 hours in the countdown. High speed films are reviewed after launch to identify Ice/Frost/Debris sources and investigate potential vehicle damage. This report documents the Ice/Frost/Debris conditions and their effect on the Space Shuttle.			
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